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Haddock in Management Unit 4TVW: An Assessment of Present Resource Status - 1986

by

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Abstract

The nominal catch of 4TVW haddock in 1985 of 11645 t represented 77.6% of the TAC. Catches in the first half of 1986 (to 30-06-86) totalled 7153 t. The recent shift of the focus of this fishery from 4W to 4Vs was intensified in 1985 with the closure of 4W during the latter half of the year and is, according to industry officials, being maintained by good catch rates. Use of commercial catch rates as indicators of overall stock abundance is not warranted due to the spatial shift in the fishery coupled with the likely targeted exploitation of the abundant 1981 and 1982 year-classes. An analysis of research vessel survey data, indicates that 4W may be the source of new recruits for the stock. These surveys also indicate below average recruitment since 1982 and a reduction in the proportion of fish in the population at ages 8+. Values of terminal fishing mortality (Ft) and partial recruitment were estimated by assuming a linear relationship between numbers per tow at age 5 observed in research vessel surveys and those generated by SPA at various levels of Ft. Minimization of along cohort residuals from this relationship occurred at Ft=1.00 in 1986. Since these were based on half year values the resultant values of PR and Ft for 1985 were in turn used as input to SPA. This analysis indicated that 74% of the biomass of 4TVW haddock in 1985 was accounted for by only two year-classes (1981-1982) and that the biomass at ages 6+ has been declining steadily since 1981. Calculation of spawning stock biomass was estimated at 11,400 t, placing it at a level where the probability of its producing a large year-class appears to be low. Assuming that the 1986 catch equals the 1985 catch of 12,000 t and a recruitment value of 6.3 million fish in both 1986 and 1987 (given the low level of spawning stock biomass) results in projected F0.1 catches of 3494 t in 1986 and 3844 t in 1987.

Résumé

Les prises nominales d'aiglefin des divisions 4TVW en 1985 ont été de 11 645 t, représentant 77,6 % du TPA. Pendant la première moitié de 1986 (jusqu'au 30 juin), les prises ont totalisé 7 153 t. Le déplacement récent de cette pêche de 4W à 4Vs s'est accentué en 1985 avec la fermeture de 4W pendant la seconde moitié de l'année et, selon les responsables de l'industrie, se maintient grâce à de bons taux de capture. L'utilisation des taux de capture de la pêche commerciale comme indicateur de l'abondance globale du stock n'est pas justifiée étant donné le déplacement de l'aire de pêche et le fait que l'effort de pêche est probablement dirigé sur les classes d'âges abondantes et 1981 et 1982. Les résultats des relevés par navires de recherche indiquent que la division 4W pourrait être la source de recrutement du stock. Ces relevés montrent aussi que le recrutement est inférieur à la moyenne depuis 1982 et que la proportion de poissons d'âge 8+ dans la population diminue. On a estimé la mortalité par pêche de dernière année (F_t) et le recrutement partiel en supposant l'existence d'une relation linéaire entre les nombres par trait de chalut à l'âge 5 observés dans les relevés par navires de recherche et ceux obtenus par l'ASP pour différents niveaux de F_t. D'après cette relation, les nombres minimum de survivants dans les cohortes en 1986 correspondaient à F_t=1,00. Comme ces valeurs sont basées sur une demi-année, les RP et F_t obtenus pour 1985 ont été utilisés pour l'ASP. Cette analyse a indiqué que 74 % de la biomasse d'aiglefins de 4TVW en 1985 provenait de deux classes d'âge (1981-1982) et que la biomasse des poissons d'âge 6+ baissait constamment depuis 1981. La biomasse du stock en reproduction a été estimée à 11 400, niveau peu suspectible de produire une grande classe d'âge. Si on suppose que les prises de 1986 sont égales a celles de 1985, soit 12 000 t, et que le recrutment annuel est de 6,3 millions de poissons pour 1986 et 1987 (étant donné la biomasse du stock en reproduction réduite), on prévoit des $F_{0.1}$ de 3 494 en 1986 et de 3 844 t en 1987.

Introduction

Through the 1950's and early 1960's nominal catches of 4TVW haddock averaged approximately 25,000 t annually. Between 1966 and 1976 catches declined, as the result of a collapsing stock, to a minimum of just under 1400 t (Table 1). Haddock catches in division 4T although significant through the 1950's and early 1960's have totalled less than 500 t annually since then. Recent TACs and catches for 4TVW haddock are given below (ooo'st).

	1978	1979	1980	1981	1982	1983	1984	1985	1986
TAC	2	2	15	23	23	15	15	15	17
Nominal catch	6	3	15	20	15	9	8	11[1]	7[2]

1 provisional statistics
2 provisional statistics for landings ending 30-06-86

TACs increased from 2,000 t in 1979 to 23,000 t in 1981; TACs have been established primarily on the results of SPA calibrated with a research vessel abundance index. Quotas since 1981 have declined to 15,000 t and during this time the fleet has not been able to catch its allotment. Between 1983 and 1985 it has been suggested that avoidance of the then unmarketably small 1980 and 1981 year-classes contributed to these low catches. The presence of these numerous small fish resulted in the closure of 4W to trawlers in the spring of 1985.

Landings statistics for 4TVW haddock indicate that Subdivisions 4Vs and 4W have generally contributed the largest proportions of the total catches (Table 1). It is noteworthy that in 1985 and in the first half of 1986 catches in 4Vs exceed those of 4W for the first time since 1954.

Prior to 1980 landings of haddock from 4Vs represented only a small fraction of that taken in 4W; however, since then the proportion of landings from Subdivision 4Vs has increased:

	1980 %	1981 %	1982 %	1983 %	1984 %	1985 %	1986 %
4W Jan.-June	42	75	76	74	36	21	38
July-Dec.	43	13	8	6	16	1	
4V Jan.-June	6	8	6	12	16	56	62
July-Dec.	9	4	11	8	32	22	

The spatial history of the fishery, since the extremely low catches observed in 1974 (Figure 1), indicates that landings in 4W have been declining in recent years while those in 4Vs have increased. This increase was particularly apparent between 1984 and 1985 when 4W was closed to trawlers from May until the end of the year. Landings from 4Vs in the first half of 1986 are already higher than in any recent year, save 1985.

A slight and localized resurgence of catches is also evident in 4W in 1985. Discussions with industry officials indicate that catch rates in 4Vs are likely to result in much of the fleet's effort being expended there in the remainder of 1986.

The significance of the shift in the focus of the fishery is its possible effect on the calibration and tuning of sequential population analyses by effecting selection ogives and the relative match between exploited and surveyed populations.

In the past, most of the catch has been taken in Division 4W by tonnage class (TC) 4 and 5 otter trawlers in the spring. Longliner catches typically represent 15-20% of the total and are more evenly distributed throughout the first year. Trawlers continue to dominate the fishery in 1985 and 1986 (Table 2).

Age Composition of Removals

Removals-at-age for small mesh and non-small mesh gear were estimated separately. Small mesh removals were estimated by applying summer research vessel survey age-length keys to length-frequency estimates derived from samples of haddock by- catch in the USSR small mesh fishery. Total amounts of haddock by-catch in the USSR silver hake fishery have been estimated based on Observer determined ratios of haddock by-catch (Table 3). Other foreign non-small mesh landings are listed in Table 4, as reported by FLASH . These data are not yet available for 1986.

Removals by domestic non-small mesh gears were calculated on a semi-annual basis for trawlers and an annual basis for all other gears. Age-length keys used were applied to landings by trawlers in January-June and July-September, and to landings by other gears from January-December. Removals-at-age for the first half of 1986 were determined for trawlers and other gears separately using summer R.V. length-weight coefficients. Slopes and intercepts of the length-weight relationships used in generating age-length keys since 1970 are listed in Table 5. A summary of available samples from commercial landings since 1970 is presented in Table 6. Details of the calculation of removals at age prior to 1970 are given by Mahon et al (1985). Annual removals at age and weighted mean weights at age since 1948 are shown in Tables 7 and 8. The estimated catch at age for 1986 differed from that projected by the 1985 assessment in that the contribution of age 4 fish was significantly higher (57% vs 26%). The comparison of observed and predicted age composition for 1985 is as follows:

Age	Observed (%)	Predicted (%)	Ratio
1	0.9	0.18	5.00
2	0.5	0.49	1.02
3	2.9	12.49	0.23
4	57.4	26.14	2.20
5	29.8	42.33	0.70
6	6.3	11.42	0.55
7	1.6	4.21	0.38
8	0.3	2.10	0.14
9	0.1	0.46	0.22
10	0.0	0.15	0.00
11	0.0	0.02	0.00

The differences between observed and predicted age compositions were large and may be related to changes in the spatial distribution of the fishery.

Abundance Indices

Commercial Catch Rates

Catch rates by Scotia-Fundy otter trawlers, TC 4 and 5, are difficult to interpret owing to the shift in location of these fisheries. During the first half of 1986 catch rates by TC 4 trawlers fishing in Division 4W increased sharply (Figure 2a) following a slow decline since 1980. However, effort has been extremely low since 1984 (Table 9). Tonnage class 5 vessels fishing in 4W also show a substantial increase in catch rates in 1986 but again at reduced effort levels relative to the 1980-1984 period.

Catch rates in Subdivision 4Vs are based on substantial expenditures of fishing effort and show an increase for TC 4 vessels from 1984 to 1985 with a continued high catch rate in 1986 (Figure 2a). Catch rates for TC 5 vessels (Figure 2b) increased from 1983 to 1985 with a slight decline in 1986. It is likely that these increases in catch rates in recent years are the results of the targeted exploitation of the extremely abundant 1981 and 1982 year-classes (ages 4 and 5 in 1986) which are now becoming fully recruited to the fishery.

Catch rates for the latter half of the year (which has traditionally accounted for a smaller proportion of the total annual catch and effort in both 4W and 4Vs) are not yet available for 1986, but are given for previous years (Table 10).

Research Vessel Index

The 1986 July groundfish survey data was added to the existing survey data set and the entire abundance series recalculated from 1970 to 1986. The stratum means were based on the Delta distribution and the stratified mean catch per tow at age calculated (Table 11). The mean catch per tow for all ages combined is given in Figure 3 and Figure 4 has mean catch per tow for groupings of ages 0-3, 4-7, and 8+. The percent age composition estimated from the RV surveys is given in Table 12.

The RV catch rates were also calculated for subsets of the survey area. Unit Areas 4Wh, 4Wj, 4Wk, and 4Wl were combined and referred to as 4W- West. Mean catch per tow and percent-at-age for 4W-West are given in Tables 13a and b, respectively, and Figure 5 plots the mean numbers per tow of the age groups 0-3, 4-7, and 8+. The survey index was also calculated for 4Vs (Unit Areas 4Vb and 4Vc combined). Mean catch per tow and percent at age are given in Tables 14a and b, respectively, for 4Vs. The mean catch per tow is given in Figure 6 for age groupings 0-3, 4-7, and 8+.

For the stock as a whole, abundance at ages 0-3 has declined since 1983 while abundance at the older ages 4-7 remains very strong (Figures 4, 5, and 6). In 4W-West abundance at ages 0-3 is at its lowest observed in the survey and hence ages 4-7 are at the highest ever. (Figure 7). The percentage ages 4-7 in 4Vs (Figure 8) is the second highest level in the survey after the 1985 point. The percentage at ages 0-3 is the third lowest after 1970 and 1985. The value in 1970 is affected by the high proportion of older (8+) fish in the population at that time.

Comparisons between areas 4W-West and 4Vs are made for ages 0-3 in Figure 9 and for ages 4-7 in Figure 10. The two figures both show that 4Vs has a much more dynamic age composition with larger and more rapid shifts in the percentage in each age grouping. For example, in Figure 9, the 4Vs values range from less than 5% (1970) to more than 95% (1978) while 4W-West range from a high of less than 90% (1977) to a low of slightly over 25% (1986).

Examination of the percent-at-age data (Tables 13b and 14b) for the two areas showed that, the 0-group haddock are almost never found in 4Vs (1982 being the only year) and that there are relatively fewer older fish (8+) in 4W-West. Figures 9 and 10 seem to suggest in a number of places that the appearance of year-classes in 4Vs is lagged behind 4W-West by 1 year. Cross-correlations between ages, within and between areas were calculated to investigate the strength of any lagging effect.

Figure 11 shows the lagged correlation in 4W-West for ages 1 and 2, 2 and 3, and 3 and 4 (Figures 11a, b, and c, respectively). A strong correlation exists between ages 1 and 2 when age 2 is lagged 1 year. This is a tracking of year-class strengths from ages 1 and 2. However at ages 2 to 3 (Figure 11b) and ages 3 to 4 (Figure 11c) there is no apparent pattern of year-class strength.

Between areas 4W-West and 4Vs the correlation between ages 0 and 1 when lagged 1 year is 0.95 (Figure 12a) and between ages 0 and 2 it is 0.90 when lagged 2 years (Figure 12b). Correlations between ages 1 and 2 or 2 and 3 between areas 4W-West and 4Vs are present with a lag of 1 year but also with a lag of 2 years (Figures 13a and 13b, respectively). They are much weaker then between ages 0 and 1 or 0 and 2. Figure 14a shows the cross correlations for the sum of ages 0 to 3 in each area. The decreasing correlation pattern with lags of 1 to 4 is caused by the 4 terms in the sum of the abundances. Taking a first order difference over the sum will remove the effects of trend or change in the mean. In Figure 14b this is done leaving once again a strong correlation with a lag of 1 year and negligible correlation with other lags.

This leads to a reasonably strong conclusion that the population of age 1 fish in 4Vs is derived from 0-group fish spawned in 4W-West. This is supported by the correlations of 0-group in 4W-West and 1 year olds in 4Vs the subsequent year and the fact that the survey has only found 0-group in 4Vs once in 17 years.

Estimation of Stock Abundance

I. Estimation of Partial Recruitment and Terminal F

Calibration of the SPA for this stock has been consistently difficult. This year is no exception. Since the subcommittee recommended that the SPA for 4TVW haddock be done assuming a linear model relating RV and SPA data, this was pursued. The SPA using the estimated total removals at age (Table 7) and delta mean catch per tow RV estimates (Table 11) was calibrated using an iterative procedure developed by O'Boyle (1986).

Cohort analysis was conducted assuming a natural mortality rate of 0.2. Analysis of the research survey results indicate a heterogeneous distribution of age classes within the stock area. These differences are particularly apparent between area 4W-west where the fishery was concentrated prior to 1983 and Subdivision 4Vs, where the fishery has come to be centered during the past few years. The implications of the differential distribution of age classes coupled with the fact that the fishery is exploiting one area preferentially has implications for the calibration of SPA which have not been fully investigated.

Since the spatial and temporal changes in the fishery mean that the practice of using an historical average will result in changes to the partial recruitment, the use of an historical PR pattern is inappropriate. For the present analysis, age 6 fish were assumed to be fully recruited to the fishery based on the age specific pattern of fishing mortalities observed in the historical F matrix. Initial age by age calibration of SPA suggested that F on age 6+ was lower than that estimated at age 5 in the terminal year. This observation was inconsistent with the age specific pattern of F for previous years. To determine the partial recruitment vector the mean ratio of Fs at age 5 to age 6+ was calculated for the series 1981 to 1985. A trial SPA assuming F at age 5 of 0.65 gave an initial F at ages 6+ of 0.95. The partial recruitment values at ages 5 through 2 were then estimated successively by minimization of the sum of standardized residuals squared along cohorts. This resulted in the PR vector given below:

Age	1	2	3	4	5	6	7	. . .
PR	0.01	0.01	0.03	0.35	0.65	1.00	1.00	. . .

As was mentioned previously, a linear relationship between research vessel and SPA mean numbers at age was assumed. This PR vector was then used to calculate SPAs with various levels of input F at ages 6+ until the best relationship between SPA and RV numbers at age 5 was obtained. The criterion for judging best fit was the minimization of along cohort residuals. This occurred at a terminal F of 1.00 (Figure 15a). The pattern of predicted population trends over time resulting from these values of PR and terminal F show a good correspondence to the pattern observed from the July surveys

(Figure 15b). The residuals of the observed and expected values over the time period examined (Figure 15c) show no easily definable patterns indicating that trend in the predictions follows the trend in observations.

The high Fs at ages 6+ are consistent with the results of research surveys which indicate that the proportion of animals at older ages has decreased for the past three years. In 1986 there were no fish older than age 8 observed in the survey (Table 11). The high fishing mortalities are inconsistent with catch at ages 6+ in 1982, 1983, and 1984 which resulted in large residuals from the linear relationship between RV and SPA numbers for those years (Figures 16a, b, c). The fluctuations in these age groups may be the result of survey variability; however, if they reflect the true dynamics of this portion of the population, SPA is not able to model these changes by adjusting input Fs. Changes in natural mortality rate may need to be incorporated in an alternate model to approximate these dynamics. Alternatively, the fish may have become unavailable to the fishery through some other mechanism such as emigration. Preliminary evidence of abundance of haddock in Division 4T, Subdivision 3Ps, and Divisions 3NO is not inconsistent with the hypothesis of emigration.

Estimation of Population Abundance

The one-half year PR vector and terminal F value estimated for 1986 were used as input to SPA and resulted in the estimation of the PR and F vectors for 1985 as given below:

Age	1985		1986	
	PR	F	PR	F
1	.007*	.010**	.01	.01
2	.007	.009	.01	.01
3	.012	.016	.03	.03
4	.304	.418	.35	.35
5	1.000	1.347	.65	.65
6	1.000	1.528	1.00	1.00
7	1.000	2.507	1.00	1.00
8	1.000	2.832	1.00	1.00
9	1.000	1.218	1.00	1.00
10	1.000	.519	1.00	1.00
11	1.000	1.800	1.00	1.00

* Assuming full recruitment at age 5.

** Set to .01 since the catch of age 2 animals in the 1986 fishery is not known.

The 1985 values were in turn used as input to SPA using the full catch at age matrix given in Table 7 and omitting the 1986 values (since these are based on half year catches only). This run of SPA generated the results shown in Tables 15 through 19. These tables list for the years 1948-1985 estimated population numbers at age (Table 15), mean population biomass at age (Table 16), catch biomass at age (Table 17), population biomass at age at the beginning of each year (Table 18), and the fishing mortality at age including the average weighted fully recruited fishing mortality for each year (Table 19).

These analyses indicate that beginning of year biomass in 1985 was approximately 35,000 t which is roughly equivalent to the level estimated for the late 1970s and early 1980s (Table 18). The 1981 and 1982 year-classes (ages 4 and 3, respectively in 1985) are estimated to account for 74% of that total biomass (Table 18) and 49% of the catch in 1985 (Table 17). The results also show that biomass at ages 6+ has been declining steadily since 1981, while incoming biomass estimated at ages 1 and 2 in 1985, is low relative to previous years (Table 18).

Estimation of Recruitment

Two recruitment scenarios were investigated for the 1984, 1985, and 1986 year-classes. Geometric mean recruitment at age 1 in the previous 5 years (1980-84) was calculated as 25.6 million fish (Table 15). However, the 1985 and 1986 surveys indicated that the 1985 and 1986 year-classes are not as strong as the year-classes from the early 1980s (Table 11). A second recruitment value of 6.3 million fish was therefore calculated from the geometric mean of 1970-74 age 1 (Table 15) since this was more representative of recruitment in poor years.

Although there is no predictive relationship between female spawning stock biomass and recruitment at age 1 for 4TVW haddock, analysis of this relationship for 1948 to 1983 indicates that low levels of female spawning stock biomass result in a lower probability of good recruitment (Mahon et. al. 1985). The 1985 CAFSAC Advisory Document indicates that levels of female spawning stock biomass of 16,000t should be considered a threshold below which large year-classes have not been observed. The estimated female spawning stock biomass in 1985 is approximately 11,400 t placing it well below this threshold.

Prognoses

Since the half year catch in 1986 already exceeds 7,000 t and the $F_{0.1}$ catch for 1986 is slightly over 3,400 t under either recruitment assumption discussed above, we cannot base projections on the assumption of $F_{0.1}$ catch in 1986. The assumption was made that 1986 catch would equal the 1985 catch of 12,000 t. The recruitment value actually used has little effect on the projected catch for 1987 however indications are that recruitment will be low. Recruitment in both 1986 and 1987 was set at 6.3 million given the low levels of spawning stock biomass. Catch projections were made using the following parameters:

Age	1985 Catch	Population Numbers 1985 SPA	Population Numbers 1986 Projected	PR 1985	Weights 1985
1	133	6346	6346	0.007	0.12
2	69	8496	5076	0.007	0.197
3	411	28562	6894	0.012	0.462
4	8006	25677	23013	0.304	0.698
5	4162	6014	13840	1.000	0.986
6	881	1212	1346	1.000	1.429
7	232	268	216	1.000	1.926
8	47	53	18	1.000	2.350
9	14	22	3	1.000	2.964
10	2	5	6	1.000	2.970
11	1	2	2	1.000	3.730

The following $F_{0.1}$ catches were estimated:

1986 ---------- 3,494 t
1987 with 12,000 t caught in 1986 -- 3,844 t

References

Mahon, R., P. Simpson, and D.E. Waldron. 1985. The Eastern Scotian Shelf (4VW) Haddock Stock and Fishery in 1984 with an Historical Perspective on Stock and Recruitment Back to 1948. CAFSAC Res. Doc. 85/47.

O'Boyle, R., and D. Wallace 1986 An Evaluation of the Population Dynamics of 4X Haddock during 1962-85 with yield projected to 1987. CAFSAC Res. Doc. 86/98.

Table 1. Nominal catches (t) of eastern Scotian Shelf haddock (4TVW) by NAFO Division and country as reported to NAFO (from NAFO Statistical Bullentin).

	4T					4Vn*					4Vs					4W						
Year	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Total	TAC
1954	5918	1044			40	5549	405		1058	24						12323	1956		17		28334	
1955	3101	31				3339	450		1183	13						12777	1217				22111	
1956	2861					4899	147		1350	12						18273	1661		354		29557	
1957	1740	1				5869	120		747	9						19960	1533		132		30111	
1958	2599			151		3166	71		1343	6						17572	427		1593		26928	
1959	2996	1		64		1594	159		69		3456	111		2870		21156	4804		640		37920	
1960	2041					1317	6		97		1187	18		3926	1	20093	127		1024		29837	
1961	1297			273	2	1055	1		47	1	846			1526	7	22277	23	151	1441	16	28963	
1962	1132			10		1097	1		5	2	1235			1076		15566	51	2567	3224		25966	
1963	1019			46		1213	1	6	64		1061	1		2828	195	11002	60	3295	4915	866	26572	
1964	461			1		958			59	52	677	11		2057	2	9810	42	4391	2884	1889	23294	
1965	432			3	3	402			53	84	1201			1806	47	7007	8	42876	1500	96	55518	
1966	149			1		311		516	30		1494			940	9	8259	19	9985	1885	51	23649	
1967	112			9		203		95	26	31	898			839	9	7180	5	459	1046		10912	
1968	144				4	127			70	6	1128		59	1702	23	8392		195	1458	10	13318	
1969	167				3	245				112	726			631	66	8270		235	864	1	11320	
1970	160					395	2		75	1	620		34	830	16	4754	574	636	1332		9429	
1971	151					466			215	1	1133		11	1114		7940	497	464	1477		13469	
1972	60					362	3		136	19	421		3	599	37	2096	70	103	737	102	4748	
1973	21				2	286			76	164	233			431	9	2830	173	76	95	18	4414	
1974	17				14	161			3	1	147		30	174	196	907	6	102	521	78	2357	(0)
1975	35				2	67			15	4	107	1		48	3	1393	20	52	63	59	1868	(0)
1976	12					40				1	52	1	9		1	1198	31	15			1360	(2000)
1977	8					189				8	144				1	2845	1	14		38	3248	(2000)
1978	18					119				3	441		3		38	4949	82	139		109	5901	(2000)
1979	59					194				11	650				2	2339		104		73	3433	(2000)
1980	81					188				42	1841					12448		209		31	14840	(15000)
1981	177					119				25	1796					17684		187		21	20009	(23000)
1982	47					183				23	2373					12498		53		49	15226	(23000)
1983	30					206				17	1542					7302		149		166	9412	(15000)
1984	120					299				11	3195		2		1	3992		168		233	8021	(15000)
**1985	489					593				59	7294				3	2862		275		79	11645	(15000)
**1986						333					4093					2727					7153	(17000)

* Between 1954 and 1958 catches for 4Vn and 4Vs were combined as 4V.

** provisional to 30/06/86

Table 2 . Canadian (N, Q, & Nfld.) nominal catches (t) of eastern Scotian Shelf haddock (4TVW) by gear.

Year	Otter Trawler	Danish/Scottish Longliner	Danish/Scottish Seiner	Miscellaneous	Total
1960	20835	1077	23	696	22631
61	22060	448	52	1377	23937
62	16453	665	76	705	17899
63	11943	511	147	526	13127
64	10679	70	62	874	11685
1965	8033	352	66	160	8611
66	10222	233	19	130	10604
67	7855	126	25	573	8579
68	8819	296	16	364	9495
69	8603	289	30	341	9263
1970	5056	479	20	262	5817
71	8709	538	77	179	9503
72	2141	528	76	138	2883
73	2459	628	28	232	3347
74	543	493	17	162	1215
1975	593	873	10	82	1558
76	383	657	10	75	1125
77	2198	729	26*	170	3123
78	4009	1069	67	340	5485
79	1745	1232	66	147	3190
1980	13063	933	229	270	14495
81	17859	1253	464	113	19689
82	12346	1567	890	249	15052
83	6969	1254	541	235	8997
84	6188	908	451	112	7659
85	9532	----------1731----------			11263
86*	6559	---------- 591----------			7150

* Landings to 30-06-86 only

Table 3. Estimation of small mesh removals of haddock in 4VW in silver hake directed fisheries by Cuba, Bulgaria, Romania, Japan, Portugal, and the USSR 1970 to 1983. In 1984 The GDR also carried out directed fisheries for silver hake.

Year	Nominal Catch of Silver Hake (t)	IOP Haddock By-Catch Ratio (%)	Reported Catch of Haddock (t)	Estimated By-Catch Of Haddock (t)
1970	164,013	0.82*	670	1345
1971	122,616	0.82*	175	1005
1972	108,828	0.82*	106	892
1973	269,420	0.82*	76	2209
1974	87,497	0.82*	132	717
1975	98,994	0.82*	109	812
1976	90,483	0.82*	24	742
1977	30,019	0.64	33	192
1978	45,966	1.25	229	575
1979	50,374	0.51	176	257
1980	37,709	0.75	229	283
1981	37,554	0.80	201	300
1982	58,132	0.40	94	233
1983	34,259	1.64	326**	562
1984	72,297	1.33	557**	959
1985	76,003**	0.72	357	547

* Mean of 1977-1979 weighted by-catch observed.

** FLASH

Table 4. Foreign removals (t) of 4VW haddock in 1985 as reported by FLASH and the Canadian International Observer Program.

Country	Fishery (Main Species)	Area	Mesh (mm)	FLASH Catch Haddock (t)	Observed Catch Haddock (t)	% Observed	Reported Catch (t) of Main Species Caught	% of Haddock to Main Species
Cuba	silver hake	4W	60	85.70	49.70	49	17,682.00	0.58
France	cod	4TVn	130-150	57.41	58.21	100		1.09
Japan	silver hake	4VsW	60-70	0.40	0.20	59	117.60	0.28
	redfish	4VsW	75-130	2.20	1.07	35	922.40	0.18
Portugal	cod	4Vs	130	20.39	39.69	100	954.00	4.30
	silver hake	4W	60	4.10	3.56	100	1,337.60	0.26
USSR	silver hake	4W	60-68	298.80	175.50	40	56,865.60	0.79

Table 5. Grouping of catch by gears and time period for estimation of removals-at-age. Trawlers are primarily stern and side bottom trawls but also pair trawls, other is primarily longline, Danish seine, and Scottish seine (for 1948-1969 see Mahon et al. 1985).

Year	Period	Gears	No. of Samples	Number Aged	Number Measured	Catch (t)	Weight-Length Relationship a	b	Cruise
1970	Jan - Dec	Trawlers	11	405	2172	7986	0.0062	3.136	Cameron #170 March 1970
	Jan - Dec	Other	3	107	602	779	0.0112	2.989	Cameron #175/176 July 1970
1971	Jan - Dec	Trawlers	24	966	5930	12174	0.0052	3.168	Cameron #184 March 1971
	Jan - Dec	Other	5	197	966	820	0.0088	3.035	Cameron #188/189 July 1971
1972	Jan - Dec	Trawlers	7	255	1661	3802	0.0036	3.261	Cameron #196 March 1972
	Jan - Dec	Other	1	29	200	817	0.0133	2.943	Cameron #200/201 July 1972
1973	Jan - Dec	Trawlers	8	299	1831	3407	0.0036	3.261	Cameron #196 March 1972
	Jan - Dec	Other	3	100	652	927	0.0096	3.017	Cameron #212/213 July 1973
1974	Jan - Dec	Trawlers	1	37	364	1545	0.0089	3.035	Cameron #225/226 July 1974
	Jan - Dec	Other	2	70	459	680	0.0089	3.035	Cameron #225/226 July 1974
1975	Jan - Dec	Trawlers	4	136	1048	778	0.0045	3.204	Cameron #219 March 1974
	Jan - Dec	Other	1	30	200	982	0.0094	3.023	Cameron #236/237 July 1975
1976	Jan - Dec	Trawlers	3	106	850	424	0.0191	2.837	Cameron #250/251 July 1976
	Jan - Dec	Other	3	89	478	912	0.0191	2.837	Cameron #250/251 July 1976
1977	Jan - June	Trawlers	3	105	616	548	0.0103	2.983	Cameron #259 March 1977
	July - Dec	Trawlers	11	319	2419	1684	0.0108	2.996	Cameron #265/266 July 1977
	Jan - Dec	Other	4	133	885	982	0.0108	2.996	Cameron #265/266 July 1977
1978	Jan - June	Trawlers	18	582	5776	3453	0.0019	3.425	Cameron #274 March 1978
	July - Dec	Trawlers	2	55	507	649	0.0103	3.000	Cameron #279/280 July 1978
	Jan - Dec	Other	5	164	1068	1536	0.0103	3.000	Cameron #279/280 July 1978
1979	Jan - June	Trawlers	3	80	650	847	0.0063	3.117	Hammond #13/14 March 1979
	July - Dec	Trawlers	6	189	1324	878	0.0050	3.187	Hammond #26/27 Oct-Nov 1979
	Jan - Dec	Other	12	347	2675	1528	0.0057	3.155	Cameron #292/293 July 1979
1980	Jan - June	Trawlers	24	759	5527	7077	0.0069	3.091	Hammond #33/34 March 1980
	July - Dec	Trawlers	22	619	5021	6122	0.0049	3.197	Hammond #42/43 October 1980
	Jan - Dec	Other	6	180	1421	1412	0.0117	2.970	Cameron #306/307 July 1980
1981	Jan - June	Trawlers	29	642	7450	15709	0.0070	3.102	Hammond #48/49 March 1981
	July - Dec	Trawlers	14	374	3062	2067	0.0087	3.049	Hammond #64/65 October 1981
	Jan - Dec	Other	15	407	2793	2025	0.0093	3.037	Cameron #321/322 July 1981
1982	Jan - June	Trawlers	48	1339	11563	10702	0.0059	3.143	Hammond #71/72 March 1982
	July - Dec	Trawlers	13	379	2682	1657	0.0068	3.100	Needler #2/3 October 1982
	Jan - Dec	Other	18	472	3337	2676	0.0123	2.954	Hammond #80/81 July 1982
1983	Jan - June	Trawlers	39	694	9253	6068	0.0086	3.026	Hammond #94/95 March 1983
	July - Dec	Trawlers	17	133	3642	936	0.0085	3.045	Needler #17/18 October 1983
	Jan - Dec	Other	15	131	2676	2060	0.0116	2.961	Needler #12/13 July 1983
1984	Jan - June	Trawlers	33	535	7716	3546	0.0079	3.052	Needler #24/25 March 1984
	July - Dec	Trawlers	33	315	7279	2655	0.0049	3.178	Needler #36/37 October 1984
	Jan - Dec	Other	11	256	2329	1471	0.0097	3.005	Needler #31/32 July 1984
1985	Jan - June	Trawlers	33	615	7285	7174	0.0235	2.739	Needler #41 March 1985
	July - Dec	Trawlers	14	85	3019	2358	0.0049	3.178	Needler #36/37 October 1984
	Jan - Dec	Other	6	109	1087	1731	0.0129	2.921	Needler #48/49 July 1985
1986	Jan - June	Trawlers	48	531	11140	6559	0.0102	2.982	
	Jan - June	Other	6	113	1039	591	0.0102	2.982	

Table 6. Summary of samples of commercial catch by year, quarter, and gear type for 4VW haddock. (For 1948-1969 see Mahon *et al.* 1985.)

Year	Gear	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
1970	Otter trawlers	5	5	0	1
	Longliners	0	0	2	1
1971	Otter trawlers	16	7	0	1
	Longliners	0	0	1	4
1972	Otter trawlers	5	1	0	1
	Longliners	0	0	0	1
1973	Otter trawlers	6	1	1	0
	Longliners	0	2	0	1
1974	Otter trawlers	1	0	0	0
	Longliners	0	0	1	1
1975	Otter trawlers	1	2	0	1
	Longliners	0	0	0	1
1976	Otter trawlers	0	1	1	1
	Longliners	1	0	1	1
1977	Otter trawlers	1	2	4	7
	Longliners	1	2	0	0
	Danish seine	0	1	0	0
1978	Otter trawlers	11	7	1	1
	Longliners	1	4	0	0
1979	Otter trawlers	1	2	4	3
	Longliners	1	3	5	3
1980	Otter trawlers	18	8	9	14
	Longliners	0	0	4	0
	Danish seine	0	2	0	0
1981	Otter trawlers	21	13	8	6
	Longliners	2	0	6	4
	Danish seine	0	0	2	0
	Gillnet	0	0	1	0
1982	Otter trawlers	19	29	6	7
	Longliners	4	3	7	1
	Danish seine	0	2	1	0

Table 6. Continued

Year	Gear	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
1983	Otter trawlers	12	34	13	3
	Pair trawlers	0	1	1	1
	Longliners	0	5	3	0
	Danish seine	0	3	0	1
	Gillnet	0	3	0	0
1984	Otter trawlers	8	25	12	18
	Pair trawlers	0	0	2	1
	Longliners	0	3	1	0
	Danish seine	2	0	3	1
	Gillnet	0	1	0	0
1985	Otter trawlers	12	21	6	8
	Longliners	0	1	3	1
	Danish seine	0	0	1	0

		Jan-Jun	Jul-Dec
1986	Otter trawlers	46	8
	Longliners	3	8
	Danish seine	1	2

CATCH AT AGE 4VW HADDOCK (THOUSNDS OF FISH) 19/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1	0	0	0	50	0	0	0	0	0	0	0	0
2	0	10	0	0	6	3	12	0	213	0	63	8
3	177	855	83	765	449	349	211	504	1926	647	2115	2938
4	2194	1126	2389	4967	1915	2324	2881	1021	11209	3634	3817	6803
5	3269	4330	2823	6056	6626	4113	10071	2592	2400	13199	2504	5559
6	1297	3090	5018	2216	4654	4445	2159	5132	2539	2045	8128	3388
7	1412	483	3227	1794	1831	1407	2466	1765	2866	1538	1076	7071
8	1088	357	293	1306	1079	457	1318	1642	963	1233	777	809
9	556	303	575	98	405	247	431	620	1334	341	788	528
10	433	228	230	66	96	25	265	313	340	244	276	534
11	253	142	358	79	65	18	68	51	89	92	164	213

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0	2	205	1287	2591	53595	2127	89	5	31	306	268
2	0	31	436	924	3073	32161	9696	181	13	42	129	667
3	455	409	1491	511	4074	24140	9638	1006	398	438	679	888
4	6408	4901	2039	3471	2368	15192	8887	2622	1806	1408	1743	2189
5	7580	8501	7794	3673	6023	7775	4645	2836	2926	2039	1400	2740
6	3339	4298	6190	6594	2069	4057	1217	1113	2494	1955	1365	1208
7	2164	1362	1957	3190	2906	1282	1637	441	793	939	1163	944
8	1964	1062	839	1243	1562	1234	499	597	379	279	389	1177
9	372	727	317	287	403	402	272	212	406	131	88	277
10	157	193	223	126	81	72	89	174	116	118	38	39
11	161	61	59	113	45	54	12	55	78	39	19	21

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	306	487	59	279	431	213	714	1	332	870	530	497	10
2	288	1178	233	61	676	283	433	268	376	318	433	470	360
3	671	646	975	470	157	965	811	423	2372	262	1520	1084	1514
4	751	1467	254	805	249	335	2412	1120	4334	5072	764	3207	4158
5	924	811	464	282	323	513	436	675	3238	5081	5629	2040	2225
6	668	723	298	185	189	283	715	159	1702	3010	1957	1677	821
7	345	342	114	63	132	117	203	149	249	1178	1220	530	410
8	191	159	47	30	36	80	61	16	129	139	214	235	90
9	159	60	8	8	8	19	23	5	39	105	48	29	30
10	9	99	17	4	10	15	8	6	9	30	28	18	5
11	18	2	16	1	3	6	2	2	7	10	5	19	2

	1985	1986
1	133	0
2	69	0
3	411	100
4	8006	3480
5	4162	3692
6	881	480
7	232	83
8	47	7
9	14	1
10	2	2
11	1	1

Table 7. Commercial removal-at-age for 4VW haddock. For 1986 removals are

WEIGHTS AT AGE COMMERCIAL 4VW HADDOCK 19/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
1	.082	.082	.082	.680	.082	.082	.082	.082	.082	.082
2	.305	.680	.305	.305	.680	.580	.680	.305	.500	.305
3	1.130	.838	.821	.997	.885	.954	.869	.786	.750	.762
4	1.189	1.189	1.026	1.073	1.095	1.133	1.084	1.038	.888	.986
5	1.611	1.393	1.385	1.292	1.353	1.517	1.144	1.298	1.252	1.185
6	2.250	1.821	1.861	1.626	1.662	1.822	1.574	1.476	1.527	1.557
7	2.692	2.465	2.165	2.081	2.113	2.253	1.953	1.813	1.722	1.816
8	3.022	2.925	2.634	2.332	2.615	2.761	2.127	2.151	2.127	2.074
9	3.097	2.986	2.562	1.612	2.986	3.175	2.438	2.392	2.227	2.370
10	3.383	3.162	2.838	1.391	2.514	3.868	2.691	2.597	2.283	2.388
11	3.490	3.315	3.593	2.316	2.463	3.540	3.063	2.780	2.815	2.791

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1	.082	.082	.082	.060	.049	.099	.102	.103	.090	.122
2	.530	.800	.305	.190	.200	.142	.281	.254	.267	.384
3	.704	.680	.667	.794	.453	.364	.445	.421	.356	.534
4	.976	.892	.912	.899	.825	.939	.710	.715	.698	.784
5	1.264	1.168	1.096	1.147	1.022	1.146	1.096	1.114	1.034	1.149
6	1.472	1.477	1.414	1.526	1.350	1.356	1.350	1.297	1.332	1.485
7	1.749	1.788	1.829	1.867	1.735	1.748	1.644	1.928	1.551	1.767
8	2.102	2.173	2.191	2.225	2.182	2.007	1.925	2.232	2.177	2.167
9	2.089	2.405	2.461	2.406	2.730	2.356	2.345	2.418	2.300	2.548
10	2.460	2.740	2.703	2.762	2.597	2.547	2.724	2.791	2.670	2.816
11	2.407	2.946	2.678	3.298	3.455	2.443	2.393	3.119	3.040	3.065

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	.108	.099	.108	.119	.098	.115	.122	.159	.092	.140
2	.174	.218	.332	.335	.280	.347	.407	.245	.369	.515
3	.434	.652	.638	.625	.586	.651	.643	.852	.526	.927
4	.800	.883	.913	.921	.955	.976	1.123	1.203	1.217	1.234
5	1.118	1.260	1.288	1.302	1.344	1.374	1.656	1.572	1.607	1.514
6	1.593	1.616	1.565	1.627	1.832	1.866	1.978	2.137	2.027	1.905
7	2.159	2.277	2.072	1.930	2.187	2.218	2.468	2.447	2.271	2.345
8	2.188	2.774	2.595	2.303	2.407	2.593	2.789	2.800	2.327	2.505
9	2.572	3.313	3.137	2.867	2.971	3.248	2.841	3.036	3.194	2.811
10	3.103	3.324	4.044	3.435	3.861	3.174	3.435	3.131	2.611	3.328
11	3.343	3.210	3.553	3.752	3.830	3.630	3.395	4.120	3.102	3.196

	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.080	.090	.080	.080	.060	.070	.090	.120	.000
2	.349	.335	.231	.383	.265	.186	.263	.197	.000
3	.666	.708	.716	.686	.631	.526	.577	.462	.576
4	1.067	1.167	1.031	.954	.957	.822	.738	.698	.756
5	1.511	1.554	1.361	1.266	1.203	1.160	1.036	.986	.955
6	1.967	2.020	1.846	1.677	1.606	1.428	1.462	1.429	1.476
7	2.582	2.444	2.319	2.190	2.154	1.721	1.794	1.926	2.216
8	2.687	2.965	2.662	2.708	2.779	1.905	2.154	2.350	2.010
9	3.276	3.273	3.128	3.082	3.138	2.802	2.664	2.964	2.310
10	3.497	3.435	3.402	3.409	3.513	2.065	3.240	2.200	3.180
11	3.846	4.208	3.654	3.664	4.496	1.816	3.182	5.590	3.900

Table 8. Weighted mean weights-at-age (kg) for 4VW haddock commercial removals.

Table 9. Catch rates by stern and side trawlers in 4Vs and 4W for January to June (inclusive).

	Tons/h (hours)			
	TC 4		TC 5	
Year	4Vs	4W	4Vs	4W
1968	0.29 (542)	0.68 (4043)	0.60 (190)	1.02 (601)
69	0.54 (80)	0.55 (5094)	0.38 (372)	0.94 (3490)
1970	0.27 (217)	0.38 (3939)	0.46 (406)	0.82 (1020)
71	0.49 (429)	0.54 (5541)	0.50 (915)	0.73 (4249)
72	0.57 (86)	0.29 (1399)	0.35 (230)	0.34 (1195)
73	0.29 (92)	0.34 (1820)	0.17 (148)	0.55 (822)
74	0.12 (137)	0.12 (140)	0.43 (10)	0.57 (42)
75	- (0)	0.22 (101)	0.69 (25)	0.29 (94)
76	0.18 (138)	0.44 (181)	0.10 (35)	0.17 (285)
77	0.11 (36)	0.21 (503)	0.11 (91)	0.30 (562)
78	0.18 (105)	0.65 (1065)	0.43 (413)	0.70 (874)
79	0.43 (47)	0.22 (73)	- (0)	0.48 (112)
1980	0.46 (102)	0.68 (2223)	0.74 (61)	1.54 (1502)
81	0.33 (176)	0.63 (5215)	0.72 (187)	1.00 (3855)
82	0.54 (117)	0.73 (3264)	0.54 (76)	1.25 (3436)
83	0.48 (71)	0.48 (2201)	0.30 (100)	0.77 (3180)
84	0.14 (15)	0.45 (271)	0.61 (24)	0.67 (1881)
85	0.71 (485)	0.40 (34)	0.70 (1485)	0.97 (247)
86	0.78 (525)	2.28 (96)	0.57 (1207)	1.65 (198)

Table 10. Catch rates by stern and side trawlers in 4Vs and 4W for July to December (inclusive).

	Tons/h (hours)			
	TC 4		TC 5	
Year	4Vs	4W	4Vs	4W
1968	- (0)	0.41 (2828)	0.24 (90)	0.55 (916)
69	- (0)	0.40 (814)	0.26 (90)	0.26 (226)
1970	0.15 (80)	0.37 (1276)	- (0)	3.30 (30)
71	0.63 (37)	0.48 (159)	- (0)	0.28 (161)
72	- (0)	0.21 (91)	- (0)	0.35 (128)
73	- (0)	0.14 (70)	- (0)	0.21 (38)
74	- (0)	0.11 (46)	- (0)	0.10 (50)
75	0.12 (32)	0.49 (146)	- (0)	0.35 (19)
76	- (0)	0.29 (20)	0.22 (5)	0.40 (76)
77	- (0)	0.39 (692)	- (0)	0.60 (1037)
78	0.18 (11)	0.35 (192)	0.36 (54)	0.46 (394)
79	- (90)	0.28 (90)	0.95 (77)	0.47 (175)
1980	- (0)	0.46 (2625)	0.47 (84)	0.76 (3230)
81	0.69 (47)	0.38 (534)	- (0)	0.92 (314)
82	0.71 (90)	0.36 (663)	0.40 (246)	0.46 (566)
83	0.11 (33)	0.47 (164)	0.03 (15)	0.36 (219)
84	0.50 (243)	0.09 (4)	0.67 (573)	0.53 (291)
85	0.35 (15)	- (0)	0.45 (500)	0.14 (56)

Table 11. DELTA MEAN CATCH RATES PER TOW AT AGE 4VW HADDOCK 19/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	.105	.062	.047	.000	.228	.074	.624	.363	.000	1.589
1	2.678	1.724	1.346	.635	.363	4.490	3.414	6.280	8.135	.089
2	1.108	3.691	.899	1.950	2.217	.563	3.512	13.660	10.824	15.094
3	1.821	1.121	1.302	.509	2.908	1.970	.518	11.415	12.370	22.332
4	2.049	1.636	.584	.446	.640	1.700	1.024	1.321	7.066	14.034
5	1.014	.664	.488	.154	.566	.448	.957	1.979	.500	3.309
6	.710	.360	.369	.238	.247	.808	.217	.756	.520	.383
7	.695	.153	.150	.056	.217	.208	.222	.204	.122	.302
8	.352	.260	.071	.062	.081	.085	.062	.118	.012	.098
9	.146	.012	.043	.031	.045	.045	.020	.000	.000	.000
10	.033	.000	.019	.046	.033	.052	.016	.069	.012	.038
11	.038	.000	.000	.000	.032	.000	.020	.009	.014	.018
12	.032	.000	.000	.000	.000	.018	.060	.000	.000	.000
13	.009	.000	.000	.000	.010	.013	.004	.063	.031	.007

	1980	1981	1982	1983	1984	1985	1986
0	1.486	28.622	.756	.153	.276	.011	.137
1	3.724	17.328	19.693	22.445	.301	3.440	.573
2	.355	9.470	19.491	24.793	10.921	1.084	2.245
3	21.205	.906	19.494	32.011	17.901	11.982	8.673
4	16.082	7.216	2.705	10.020	31.454	27.703	28.256
5	13.944	4.583	7.700	2.835	5.786	4.741	12.632
6	2.071	2.282	3.096	2.428	2.901	1.216	1.288
7	.358	.303	1.064	.777	1.444	.306	.384
8	.106	.101	.214	.249	.361	.062	.058
9	.017	.108	.020	.056	.108	.000	.000
10	.000	.014	.017	.042	.025	.002	.000
11	.000	.000	.000	.000	.006	.000	.000
12	.000	.000	.000	.010	.000	.000	.000
13	.000	.000	.021	.009	.016	.028	.000

TABLE 12A. PERCENT AT AGE IN 4VW RV SURVEY 21/09/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	.970	.640	.964	.000	3.008	.707	5.878	1.005	.000	2.783	2.653	40.530	1.029	.160	.386	.021	.254
1	24.814	17.781	26.861	13.108	4.782	42.774	32.157	17.309	22.987	.154	6.399	24.168	26.501	24.622	.421	6.901	1.063
2	10.277	38.064	15.228	42.088	29.218	5.387	32.944	37.709	26.345	26.275	.513	13.387	26.163	20.282	15.275	2.175	4.162
3	16.876	11.561	23.449	13.512	38.337	18.835	4.858	31.496	30.267	39.236	37.725	1.283	26.320	35.229	25.007	24.011	16.057
4	18.994	16.872	11.246	12.220	8.434	16.257	9.554	3.644	17.430	24.371	25.479	10.219	3.649	11.590	44.012	54.710	52.341
5	9.400	6.920	9.708	4.491	7.454	4.284	8.856	5.470	1.259	5.705	22.484	6.490	10.370	3.412	8.115	9.059	23.099
6	6.572	3.782	6.849	8.744	3.256	7.727	2.005	2.089	1.269	.664	3.826	3.206	4.170	3.153	4.062	2.394	2.211
7	6.444	1.580	2.999	1.860	2.863	1.988	2.041	.564	.281	.529	.689	.415	1.432	1.060	2.002	.543	.683
8	3.263	2.680	1.451	2.235	1.063	.815	.586	.327	.035	.173	.198	.129	.289	.308	.505	.124	.098
9	1.353	.120	.867	.705	.596	.427	.188	.000	.000	.000	.034	.152	.027	.067	.151	.000	.000
10	.307	.000	.379	1.036	.436	.495	.145	.189	.026	.066	.000	.020	.022	.045	.035	.005	.000
11	.348	.000	.000	.000	.424	.000	.188	.024	.032	.032	.000	.000	.000	.000	.008	.000	.000
12	.301	.000	.000	.000	.000	.174	.565	.000	.000	.000	.000	.000	.000	.051	.000	.000	.000

TABLE 13A. DELTA MEAN CATCH PER TOW IN 4W WEST RV SURVEYS 21/09/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	.180	.152	.008	.000	.536	.259	1.805	.482	.000	3.411	3.401	58.356	1.209	.313	.685	.021	.094
1	4.025	1.780	3.163	1.421	.530	12.652	6.277	12.789	11.246	.420	5.127	31.798	21.660	19.088	.617	8.985	1.072
2	1.845	4.959	.481	4.028	5.980	1.450	4.794	20.905	20.503	16.558	.301	13.039	36.834	7.340	8.595	2.443	4.489
3	3.414	1.708	1.311	1.049	7.770	6.413	1.030	20.442	18.894	22.964	34.602	1.990	19.644	9.903	12.726	13.059	14.238
4	2.764	2.465	1.050	1.088	1.619	5.892	2.562	2.119	12.743	25.200	32.455	18.953	3.942	5.107	38.758	30.677	37.664
5	1.266	1.053	1.029	.475	1.435	1.432	2.297	3.238	.974	7.535	20.879	10.693	14.405	2.523	7.440	5.621	14.001
6	1.144	.503	.529	.946	.654	2.299	.488	1.191	.975	1.018	4.133	4.595	5.898	2.533	3.708	1.795	.860
7	1.120	.221	.336	.173	.543	.607	.498	.238	.277	.748	.673	.459	1.778	.783	1.804	.291	.347
8	.320	.320	.147	.205	.168	.234	.098	.116	.031	.192	.221	.142	.177	.220	.459	.130	.041
9	.195	.015	.116	.074	.123	.149	.029	.000	.000	.000	.038	.197	.019	.015	.210	.000	.000
10	.000	.000	.062	.000	.049	.149	.043	.025	.023	.056	.000	.019	.026	.015	.058	.000	.000
11	.039	.000	.000	.000	.075	.000	.029	.018	.000	.064	.000	.000	.000	.000	.000	.000	.000
12	.061	.000	.000	.000	.000	.008	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 13 B. PERCENT AT AGE IN 4W WEST RV SURVEY 21/09/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	1.098	1.155	.098	.000	2.751	.821	9.046	.783	.000	4.363	3.340	41.612	1.145	.655	.913	.034	.130
1	24.585	13.509	38.418	15.025	2.720	40.108	31.465	20.774	17.125	.537	5.035	22.674	20.513	39.900	.822	14.257	1.472
2	11.267	37.634	5.838	42.573	30.696	4.598	24.030	33.957	31.224	21.184	.296	9.297	34.883	15.342	11.451	3.877	6.166
3	20.851	12.963	15.921	11.085	39.883	20.329	5.161	33.204	28.773	29.378	33.980	1.419	18.604	20.700	16.954	20.722	19.556
4	16.882	18.705	12.755	11.504	8.310	18.679	12.841	3.442	19.406	32.240	31.872	13.515	3.733	10.675	51.636	48.676	51.732
5	7.729	7.993	12.501	5.025	7.369	4.539	11.512	5.259	1.484	9.640	20.504	7.625	13.642	5.274	9.912	8.918	19.231
6	6.990	3.815	6.429	10.004	3.356	7.288	2.447	1.935	1.484	1.302	4.058	3.277	5.586	5.295	4.940	2.848	1.161
7	6.842	1.679	4.086	1.833	2.789	1.923	2.496	.387	.421	.958	.661	.327	1.684	1.638	2.403	.462	.477
8	1.957	2.430	1.789	2.167	.860	.742	.493	.189	.047	.245	.217	.101	.168	.461	.612	.206	.056
9	1.188	.117	1.409	.783	.631	.474	.147	.000	.000	.000	.037	.140	.018	.031	.280	.000	.000
10	.000	.000	.756	.000	.251	.473	.215	.041	.036	.071	.000	.013	.025	.031	.077	.000	.000
11	.237	.000	.000	.000	.384	.000	.147	.030	.000	.082	.000	.000	.000	.000	.000	.000	.000
12	.373	.000	.000	.000	.000	.027	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 14 A. DELTA MEAN CATCH PER TOW IN 4VS RV SURVEYS 21/09/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.081	.000	.000	.000	.000
1	.047	.302	.042	.082	.215	.101	.017	.000	.000	.037	2.630	1.022	30.149	8.918	.018	.000	.032
2	.080	.007	.780	.072	.056	.119	2.282	.087	.000	.485	.147	.189	2.837	11.326	4.211	.000	.038
3	.073	.098	.547	.133	.061	.019	.313	1.040	.013	.288	.355	.029	8.421	5.439	15.160	2.603	1.741
4	1.671	.235	.130	.110	.041	.011	.007	.519	.000	.096	.404	.069	1.352	4.631	9.137	17.096	8.322
5	.808	.149	.078	.000	.026	.076	.057	.510	.000	.029	.319	.086	3.043	2.060	1.351	2.651	3.994
6	.429	.121	.147	.000	.000	.201	.001	.091	.000	.000	.109	.116	.861	.517	.275	.328	.398
7	.230	.054	.046	.050	.026	.036	.000	.056	.000	.015	.034	.066	.454	.260	.316	.221	.021
8	.456	.056	.000	.000	.052	.000	.000	.000	.000	.000	.016	.034	.272	.106	.022	.000	.007
9	.113	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.011	.005	.066	.000	.000	.000
10	.053	.000	.000	.029	.036	.036	.000	.000	.000	.000	.000	.000	.000	.000	.000	.008	.000
11	.047	.000	.000	.000	.013	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.012	.000
12	.024	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.007	.000	.000	.000

TABLE 14B. PERCENT AT AGE IN 4VS RV SURVEY 21/09/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.171	.000	.000	.000	.000
1	1.170	29.560	2.372	17.247	40.928	16.784	.617	.000	.000	3.848	65.542	63.085	63.505	26.756	.060	.000	.221
2	1.984	.700	44.066	15.186	10.649	19.841	85.256	3.779	.000	51.108	3.661	11.646	5.975	33.982	13.807	.000	.258
3	1.812	9.546	30.920	27.908	11.614	3.175	11.679	45.149	100.000	30.277	8.842	1.763	17.738	16.319	49.702	11.362	11.962
4	41.467	23.022	7.347	23.048	7.809	1.905	.276	22.548	.000	10.142	10.058	4.261	2.847	13.893	29.955	74.635	57.188
5	20.043	14.570	4.433	.000	4.916	12.747	2.125	22.130	.000	3.098	7.946	5.310	6.410	6.179	4.428	11.571	27.446
6	10.633	11.884	8.278	.000	.000	33.487	.046	3.968	.000	.000	2.722	7.140	1.813	1.552	.901	1.434	2.733
7	5.714	5.271	2.585	10.547	4.916	6.031	.000	2.427	.000	1.529	.836	4.068	.956	.781	1.035	.964	.143
8	11.307	5.447	.000	.000	9.831	.000	.000	.000	.000	.000	.393	2.077	.574	.320	.072	.000	.050
9	2.798	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.650	.011	.199	.000	.000	.000
10	1.316	.000	.000	6.062	6.780	6.031	.000	.000	.000	.000	.000	.000	.000	.000	.000	.034	.000
11	1.170	.000	.000	.000	2.557	.000	.000	.000	.000	.000	.000	.000	.000	.000	.040	.000	.000
12	.584	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.020	.000	.000	.000

Table 15. POPULATION NUMBERS 30/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956
1	67003	38301	71132	34140	25967	121614	42549	44106	64298
2	43275	54857	31358	58238	27906	21260	99569	34836	36111
3	20337	35430	44904	25674	47682	22842	17404	81509	28521
4	24835	16490	28234	36689	20328	38632	18386	14058	66278
5	17140	18348	12482	20954	25544	14911	29527	12446	10585
6	3076	11075	11104	7665	11676	14918	8487	15062	7845
7	3335	1345	6272	4551	4270	5349	8192	4995	7688
8	2204	1453	665	2215	2102	1840	3106	4476	2493
9	1662	820	867	279	631	745	1093	1351	2179
10	761	858	397	189	140	150	386	505	545
11	398	230	496	117	95	28	100	77	130
1+	184025	179208	207911	190711	166343	242289	228799	213420	226673
2+	117022	140907	136778	156571	140375	120675	186250	169315	162375
3+	73747	86050	105420	98333	112469	99414	86681	134479	126264
4+	53411	50619	60516	72659	64788	76572	69277	52970	97743

	1957	1958	1959	1960	1961	1962	1963	1964	1965
1	79426	69253	29317	48374	33440	58619	84518	91735	91508
2	52643	65028	56699	24002	39605	27377	47808	68033	72762
3	29372	43101	53183	46415	19652	32397	22020	38305	52920
4	21609	23462	33374	40884	37589	15719	25176	17566	27675
5	44122	14403	15755	21169	27675	26341	11025	17471	12239
6	6495	24181	9527	7869	10472	14966	14514	5704	8855
7	4126	3467	12444	4735	3422	4685	6652	5917	2798
8	3701	1986	1865	3790	1918	1569	2065	2560	2215
9	1169	1915	923	794	1326	610	525	566	683
10	577	649	855	278	314	428	213	170	98
11	138	251	281	217	86	83	149	61	66
1+	243377	247697	214223	198527	175500	182796	214665	248088	271819
2+	163951	178444	184907	150154	142059	124177	130147	156353	180312
3+	111308	113416	128207	126151	102454	96799	82339	88320	107550
4+	81937	70315	75024	79737	82803	64402	60319	50015	54629

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	15246	14726	10754	6652	8077	4398	8071	7584	4572	19930
2	26425	10557	11976	8800	5419	6336	3358	6331	5768	3690
3	30472	12862	8480	9794	7167	4319	4583	2489	4118	4512
4	21485	16228	9620	6583	7622	5253	2732	3145	1454	2489
5	8913	9549	10913	6242	4115	4663	2320	1557	1247	961
6	2986	3095	5252	6287	3265	2103	1339	1064	541	602
7	3579	1344	1526	2043	3379	1438	628	492	217	174
8	1130	1449	701	532	823	1714	323	202	93	74
9	697	474	646	231	183	322	338	92	22	34
10	196	324	196	162	71	70	12	133	21	10
11	15	80	108	55	26	24	22	2	20	1
1+	111144	70686	60173	47383	40147	30640	23729	23092	18073	32476
2+	95898	55961	49419	40730	32070	26243	15658	15508	13501	12546
3+	69473	45404	37443	31930	26651	19907	12300	9177	7733	8856
4+	39001	32542	28963	22137	19484	15587	7716	6688	3615	4344

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	27180	31079	35874	10854	18526	25091	50503	43644	10387	14745
2	16065	21863	25253	28726	8885	14867	19755	40869	35283	8496
3	2966	12541	17644	20284	23276	6935	11884	15783	33036	28562
4	3268	2286	9395	13712	16224	16911	5441	8355	11941	25677
5	1309	2450	1569	5509	10213	9361	9256	3763	3938	6014
6	531	780	1542	890	3899	5432	3066	2485	1235	1212
7	325	264	382	615	585	1652	1724	739	517	268
8	85	146	110	129	369	253	287	307	126	53
9	34	37	47	35	91	185	81	41	39	22
10	20	20	13	18	24	39	56	23	7	5
11	4	8	3	4	10	12	5	21	3	2
1+	51789	71475	91832	80774	82102	80737	102060	116031	96513	85055
2+	24609	40395	55958	69920	63576	55646	51556	72387	86125	70310
3+	8544	18533	30705	41194	54690	40779	31801	31518	50842	61814
4+	5578	5991	13061	20911	31414	33844	19917	15735	17807	33252

Table 15. Population numbers at age (1948-1985) estimated SPA using input PR and F values in 1985 listed in the text.

Table 16. MEAN POPULATION BIOMASS (KG) 30/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956
1	4980	2847	5287	21024	1930	9038	3162	3278	4779
2	11963	33806	8669	16099	17197	11175	61362	9630	16313
3	20731	26561	33381	22839	38066	19588	13618	57902	18668
4	25473	17118	25052	33019	19139	38371	16507	12705	48371
5	22367	20094	13677	20501	26733	17296	24586	12941	10482
6	4709	15383	13672	9435	13474	20445	10371	16185	8837
7	6098	2380	8440	6598	6098	9297	12009	6525	9393
8	4230	3319	1170	2943	3421	3959	4485	6863	3718
9	3766	1742	1140	325	1001	1734	1855	2123	2685
10	1502	2089	651	191	174	478	516	718	676
11	1069	596	1271	202	175	76	228	161	273
1+	106888	125935	112409	133175	127406	131457	148700	129032	124193
2+	101909	123088	107123	112151	125476	122418	145537	125754	119415
3+	89946	89282	98454	96052	108279	111243	84175	116124	103102
4+	69215	62722	65073	73213	70213	91656	70558	58222	84434

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
1	5903	5147	2179	3595	1818	2598	7522	8352	5382	1148
2	14552	31221	41108	6635	6803	4920	6089	16879	12321	5031
3	20036	26780	31784	27925	13983	12969	7175	14561	14678	8058
4	17517	13889	23908	30881	28444	10921	19813	10461	11833	10270
5	39295	14913	13267	16661	23709	20279	9255	13895	7306	5690
6	7509	26014	10123	7554	10979	13844	12996	5506	7553	2740
7	5314	4519	13014	5701	4437	5550	7491	6195	3547	3654
8	5621	2916	2726	5141	2540	2081	2324	2734	2929	1643
9	2094	2746	1292	1273	1911	1030	742	627	942	1119
10	936	1082	1276	441	478	687	308	299	125	346
11	289	460	564	405	204	206	248	101	124	31
1+	119068	134685	141241	106214	95307	75086	73962	79609	66742	39731
2+	113165	129538	139062	102619	93488	72487	66440	71257	61360	38583
3+	98613	98317	97953	95983	86685	67567	60351	54378	49038	33552
4+	78576	71538	66169	68058	72702	54598	53176	39817	34360	25494

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	1623	1052	595	774	459	702	763	502	2851	2247	3929
2	3642	1888	1734	1611	1814	813	1788	2082	812	5250	10127
3	5962	3251	5648	3932	2166	2239	1254	2080	3284	1372	10099
4	10503	6245	4639	5499	3305	1997	2004	1337	2208	3456	2351
5	8256	9377	5789	3859	3469	2165	1320	1466	1140	1642	2969
6	3294	5415	7569	3486	1986	1550	994	640	960	774	1061
7	1746	2037	3056	5084	1441	822	532	328	304	509	413
8	2154	927	908	1385	1953	443	210	163	144	134	219
9	801	900	450	370	272	654	155	44	80	85	65
10	553	345	246	175	144	22	188	24	22	35	30
11	181	257	128	62	47	51	3	42	4	10	17
1+	38715	31694	30762	26239	17055	11458	9212	8707	11808	15513	31280
2+	37092	30642	30167	25464	16596	10756	8449	8205	8958	13266	27351
3+	33450	28754	28432	23853	14782	9943	6661	6123	8145	8016	17224

	1978	1979	1980	1981	1982	1983	1984	1985
1	2573	885	1330	1785	2731	2752	847	1596
2	7910	8677	1816	5107	4686	6857	8372	1510
3	10392	12874	14270	4223	6321	7247	16836	11861
4	7769	13860	12863	12116	4354	4830	6378	13372
5	1809	7237	10304	7140	6195	2632	2397	2987
6	1983	1468	4830	5419	2628	1790	926	824
7	601	1177	918	1708	1770	596	365	178
8	177	322	710	410	350	248	127	39
9	99	96	192	334	146	54	46	34
10	26	46	58	57	126	20	12	8
11	7	12	24	23	11	18	5	4
1+	33346	46655	47315	38322	29318	27044	36309	32414
2+	30773	45769	45985	36537	26587	24292	35462	30818
3+	22863	37093	44169	31430	21901	17435	27091	29308
4+	12471	24219	29899	27206	15580	10188	10255	17447

Table 16. Mean population biomass at age (1948-1985) estimated by SPA using input PR and F values in 1985 as given in the text.

Table 17. CATCH BIOMASS 30/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
1	0	0	0	34	0	0	0	0	0	0
2	0	7	0	0	4	2	8	0	107	0
3	200	717	68	763	398	333	184	397	1443	493
4	2608	1340	2452	5328	2096	2632	3124	1060	9957	3584
5	5265	6032	3909	7825	8965	6240	11522	3364	3005	15641
6	2918	5628	9338	3603	7736	8098	3399	7575	3876	3183
7	3801	1190	6988	3734	3868	3170	4816	3199	4936	2793
8	3289	1044	772	3047	2823	1262	2803	3531	2049	2556
9	1721	904	1474	158	1210	784	1050	1484	2970	809
10	1466	722	653	91	241	97	712	812	777	584
11	884	470	1287	183	160	62	209	141	250	257
1+	22152	18052	26941	24766	27501	22679	27827	21563	29369	29900
2+	22152	18052	26941	24732	27501	22679	27827	21563	29369	29900
3+	22152	18045	26941	24732	27497	22677	27819	21563	29262	29900
4+	21952	17329	26872	23970	27099	22344	27636	21167	27819	29407

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1	0	0	0	0	10	127	264	5505	191	11
2	34	6	0	6	87	131	862	8156	2590	69
3	1489	1997	304	324	675	186	1814	10161	3435	537
4	3726	6067	5845	4407	1683	3261	1680	10856	6200	2056
5	3165	6492	8310	9749	7965	4210	6600	8660	4805	3258
6	11967	5004	4723	6558	8358	8944	2792	5261	1621	1653
7	1883	12640	3958	2543	3396	5575	4778	2472	2540	780
8	1633	1758	4304	2362	1832	2495	3007	2754	1087	1293
9	1645	1271	916	1748	865	676	946	971	626	541
10	678	1462	423	532	579	320	221	201	236	490
11	394	629	432	201	202	276	107	168	37	169
1+	26614	37326	29214	28431	25652	26201	23072	55165	23370	10856
2+	26614	37326	29214	28431	25642	26073	22807	49660	23178	10846
3+	26581	37320	29214	28425	25555	25942	21945	41504	20588	10776
4+	25091	35323	28910	28100	24880	25756	20131	31343	17153	10239

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	1	3	33	32	30	56	7	44	40	30	57	0
2	2	9	43	224	81	409	95	15	249	146	151	90
3	173	286	434	555	393	420	627	401	83	895	540	300
4	1444	1244	1591	2016	718	1433	285	968	303	413	2574	1307
5	3271	2570	1802	3567	1241	1114	768	443	519	777	659	1049
6	3974	3159	2136	1965	1224	1350	588	396	384	540	1407	321
7	1711	2138	2410	1821	755	759	282	155	300	273	525	363
8	829	775	1010	2711	459	411	132	83	84	202	165	47
9	1043	433	275	795	472	196	24	24	26	52	74	16
10	360	394	153	135	35	314	60	14	25	50	29	20
11	260	126	68	77	70	6	53	4	10	19	9	8
1+	13067	11136	9957	13898	5477	6469	2922	2546	2024	3397	6190	3521
2+	13066	11133	9924	13866	5447	6413	2914	2502	1984	3367	6133	3521
3+	13064	11124	9881	13643	5366	6004	2820	2487	1735	3221	5982	3431
4+	12891	10838	9447	13087	4973	5583	2193	2086	1652	2327	5441	3131

	1980	1981	1982	1983	1984	1985
1	27	70	32	35	1	16
2	87	122	115	88	95	14
3	1699	180	959	570	873	190
4	4468	4838	731	2638	3069	5590
5	4406	6433	6772	2367	2305	4104
6	3142	5048	3144	2394	1200	1259
7	578	2580	2629	912	735	447
8	345	376	596	447	194	110
9	123	324	150	81	79	42
10	32	101	98	38	15	4
11	26	36	20	34	7	6
1+	14931	20108	15246	9603	8573	11781
2+	14904	20038	15214	9569	8572	11765
3+	14818	19916	15099	9481	8477	11751
4+	13119	19736	14140	8911	7605	11562

Table 17. Catch biomass at age (1948-1985) estimated by SPA using input PR and F values in 1985 as given in the text.

Table 18. POPULATION BIOMASS AT BEGINNING OF YEAR 30/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956
1	1908	1091	3024	1452	17658	3750	1212	1875	2135
2	7963	12954	4959	9210	18976	4637	23512	5509	7312
3	22399	17912	33552	14161	24777	18397	12355	59604	13637
4	27272	19117	26182	34431	21244	38686	18699	13351	55396
5	25961	23612	16017	24129	30774	19219	33613	14766	12066
6	6613	18968	17879	11500	17113	23424	13117	19573	11044
7	8614	3168	12454	8956	7914	10352	15455	8437	12258
8	6701	4077	1694	4978	4904	4443	6801	9175	4894
9	5094	2463	2372	575	1666	2146	2835	3048	4769
10	2599	2685	1157	357	281	510	1129	1270	1273
11	1323	772	1672	300	177	83	345	210	352
1+	116447	106818	120962	110047	145484	125645	129072	136820	125136

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
1	3377	2234	770	2057	1803	1926	2433	5395	5920	971
2	8325	13557	14522	3796	4938	2999	3988	11339	11702	4377
3	18126	19974	31920	33913	9670	9494	5942	9632	18186	9161
4	18578	20229	26446	32193	29118	12724	16422	8928	15611	11643
5	45271	16081	16821	20930	28307	25251	10723	17728	10881	7663
6	9066	31942	13017	10114	13545	18623	17088	7094	10556	3638
7	6870	5721	20189	7782	5561	7624	10220	8836	4513	5077
8	6995	3880	3635	7502	3869	3167	3853	4696	4243	2316
9	2625	3986	2075	1837	3045	1503	1191	1228	1473	1578
10	1331	1566	2046	708	818	1071	561	431	252	497
11	348	603	758	589	256	255	375	149	192	45
1+	120911	119772	132200	121420	100930	84637	72795	75455	83528	46966

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	641	1099	506	436	270	626	395	279	1716	2837	1209
2	1963	1745	1350	983	1205	613	1168	1248	638	3891	4757
3	4858	3463	3299	2673	1969	2031	1063	1946	2656	1064	7335
4	8579	6287	4075	5881	4027	2112	2379	1244	2188	3327	1841
5	8549	10217	6266	4388	5085	2581	1784	1586	1277	1820	3326
6	3835	7105	8450	4585	3043	2068	1685	892	1132	949	1364
7	2062	2732	3891	6184	2499	1185	992	465	382	716	575
8	2656	1379	1303	2001	3745	697	481	232	195	203	349
9	1115	1526	623	540	877	885	258	60	98	101	94
10	824	550	474	260	231	41	409	69	31	58	66
11	229	330	175	88	93	81	8	64	5	14	23
1+	35312	36432	30412	28020	23044	12920	10622	8085	10317	14979	20939

	1978	1979	1980	1981	1982	1983	1984	1985
1	3182	424	1041	917	2221	1486	375	897
2	5580	4702	1280	2604	2876	4321	4789	1131
3	10332	10081	11400	2759	5846	5892	10826	9957
4	9345	12091	13861	13978	4407	6019	7442	16291
5	2142	7094	12869	10693	9916	3964	3636	5131
6	2660	1554	6603	8206	4373	3257	1608	1474
7	847	1348	1266	3322	3277	1229	828	451
8	277	356	941	634	707	623	242	109
9	135	104	277	530	237	114	89	54
10	42	61	81	127	185	60	21	13
11	10	14	34	41	20	53	7	6
1+	34553	37830	49655	43810	34065	27017	29862	35514

Table 18. Population biomass at age at the beginning of each year (1948-1985) as estimated from SPA using input PR and F values in 1985 as given in the text.

Table 19. FISHING MORTALITY 30/ 9/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
1	.000	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.007	.000	.001
3	.010	.027	.002	.033	.010	.017	.014	.007	.078	.025	.056
4	.103	.078	.098	.162	.110	.069	.190	.084	.207	.206	.198
5	.237	.302	.288	.385	.338	.364	.473	.262	.288	.401	.213
6	.627	.369	.692	.385	.581	.399	.330	.473	.443	.428	.464
7	.631	.505	.841	.572	.642	.343	.404	.495	.531	.531	.420
8	.789	.317	.669	1.055	.838	.321	.633	.520	.557	.459	.566
9	.461	.524	1.322	.491	1.236	.456	.572	.708	1.129	.389	.606
10	.994	.348	1.022	.483	1.416	.203	1.415	1.154	1.173	.631	.635
11	.350	.319	.519	.416	.428	.346	.425	.392	.425	.402	.374
5+1	.402	.339	.582	.451	.471	.374	.457	.430	.482	.419	.396

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1	.000	.000	.000	.004	.017	.032	1.042	.167	.007	.001	.005
2	.000	.000	.001	.018	.022	.051	.670	.520	.019	.001	.005
3	.063	.011	.023	.052	.026	.125	.701	.430	.090	.053	.051
4	.255	.190	.156	.155	.165	.161	.933	.611	.197	.233	.270
5	.494	.504	.415	.396	.459	.480	1.211	.858	.398	.351	.448
6	.499	.633	.604	.611	.697	.512	.706	.598	.507	.744	.421
7	.989	.703	.580	.619	.755	.783	.706	.704	.451	.853	.709
8	.653	.850	.946	.895	1.095	1.122	.957	.670	.607	.908	.867
9	1.001	.729	.930	.853	.926	1.550	1.049	.566	.684	1.183	.980
10	1.170	.976	1.135	.856	1.057	.750	1.652	.693	.901	1.063	1.647
11	.628	.576	.492	.489	.629	.573	.908	.720	.444	.518	.488
5+1	.676	.596	.514	.510	.662	.612	.968	.757	.460	.554	.506

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	.043	.070	.043	.074	.014	.016	.018	.008	.022	.000	.020
2	.027	.124	.099	.230	.046	.018	.048	.014	.019	.010	.048
3	.111	.258	.177	.338	.304	.122	.060	.089	.052	.023	.119
4	.291	.617	.362	.725	.214	.442	.088	.176	.334	.095	.350
5	.472	1.048	.580	.857	.529	.392	.318	.263	.367	.146	.431
6	.620	1.008	.801	1.391	.936	.416	.501	.514	.719	.220	.659
7	.479	1.293	.935	1.462	.875	.515	.597	.670	.889	.311	.638
8	.740	1.422	1.055	2.019	.822	.583	.636	.935	.949	.145	.490
9	.755	3.060	.732	1.292	.556	.297	.310	.810	.754	.164	.649
10	.889	.954	1.616	1.719	2.590	.642	.743	1.751	1.112	.446	.549
11	.614	1.247	.910	1.507	.818	.469	.524	.654	.812	.225	.595
5+	.540	1.198	.729	1.212	.701	.419	.415	.386	.595	.170	.501

	1981	1982	1983	1984	1985
1	.039	.012	.013	.001	.010
2	.024	.025	.013	.011	.009
3	.043	.152	.079	.052	.016
4	.403	.165	.552	.486	.418
5	.916	1.115	.914	.979	1.374
6	.948	1.222	1.370	1.326	1.528
7	1.551	1.524	1.571	2.081	2.507
8	.934	1.751	1.856	1.566	2.832
9	.989	1.046	1.553	1.785	1.218
10	1.823	.793	1.985	1.349	.519
11	1.149	1.477	1.556	1.168	1.800
5+	.991	1.198	1.181	1.168	1.448

Table 19. Fishing mortality at age as estimated by SPA using input PR and F values in 1985 as given in the text.

Figure 1. Haddock landings by unit area for 1974-86.

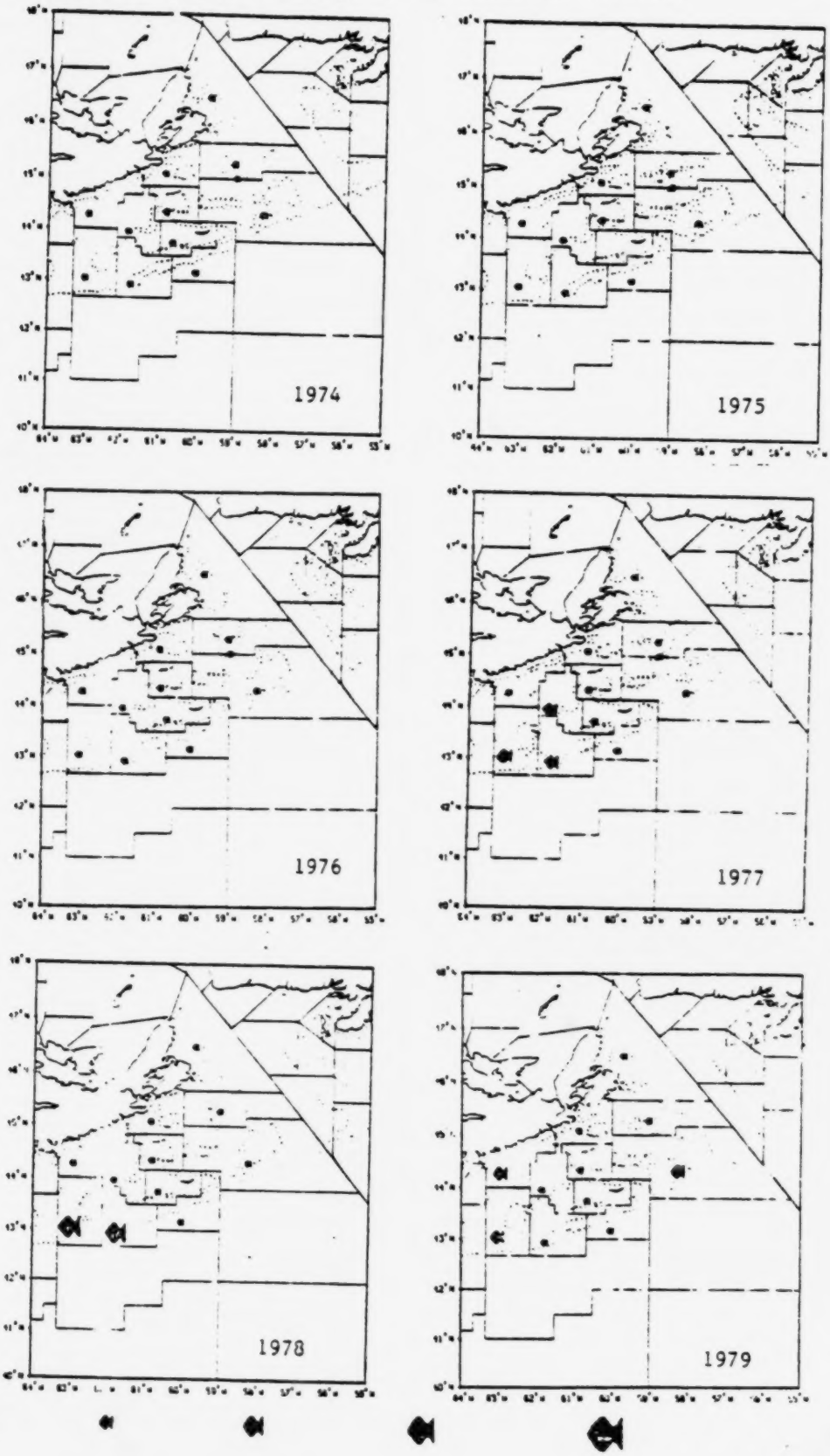
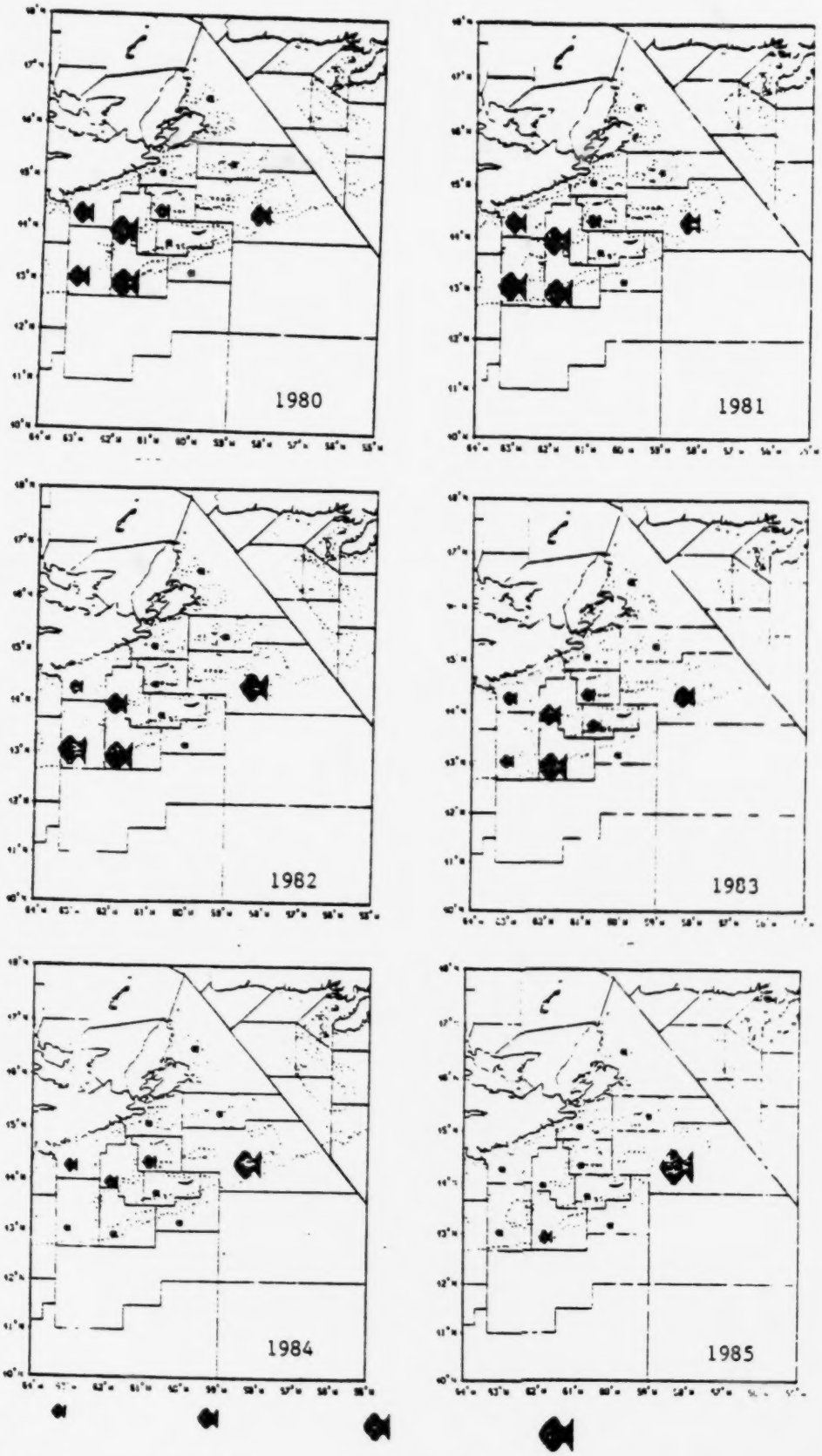
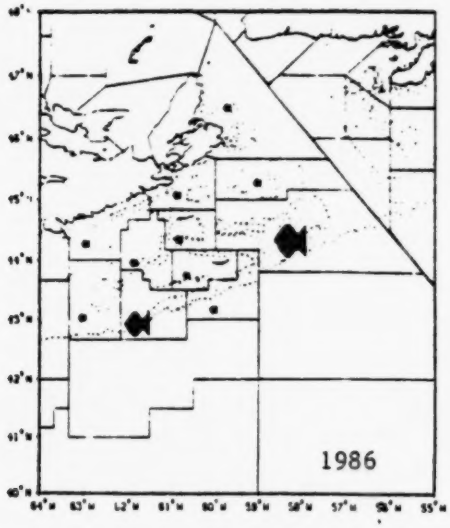


Figure 1. (Continued)



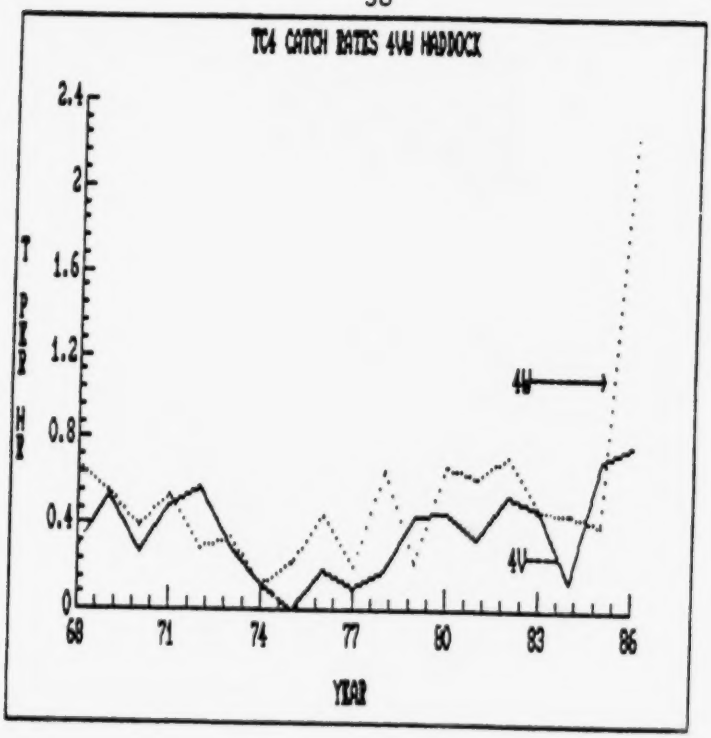
0-500 ± 500-1000 ▸ 1000-2000▸

Figure 1. (Continued)



0-500 t 500-1000 t 1000-2000t 2000-5000 t 5000-10000 t

A.



B.

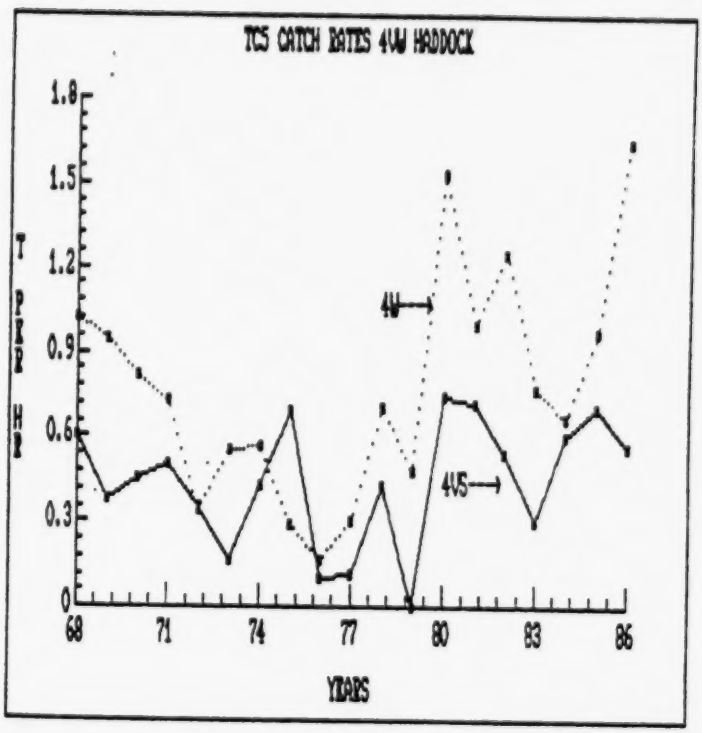


Figure 2. Catch rates by Canada Maritimes TC4 and TC5 trawlers in 4Vs and (((1969-1986) ((= Tonnage class 4; 5 = Tonnage class 5)

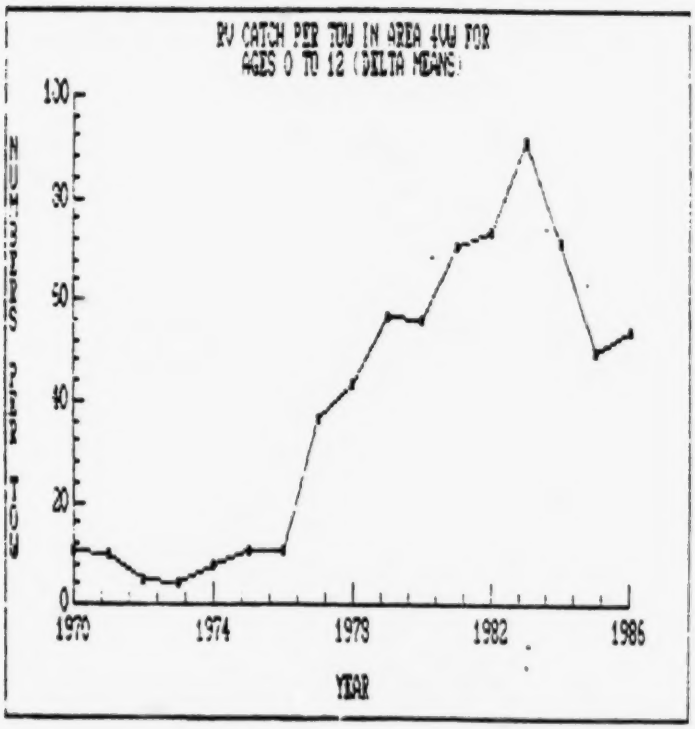


Figure 3. Mean catch per tow for haddock in 4VW during July groundfish surveys 1970-1986. The data shown are those for ages 0-12 combined.

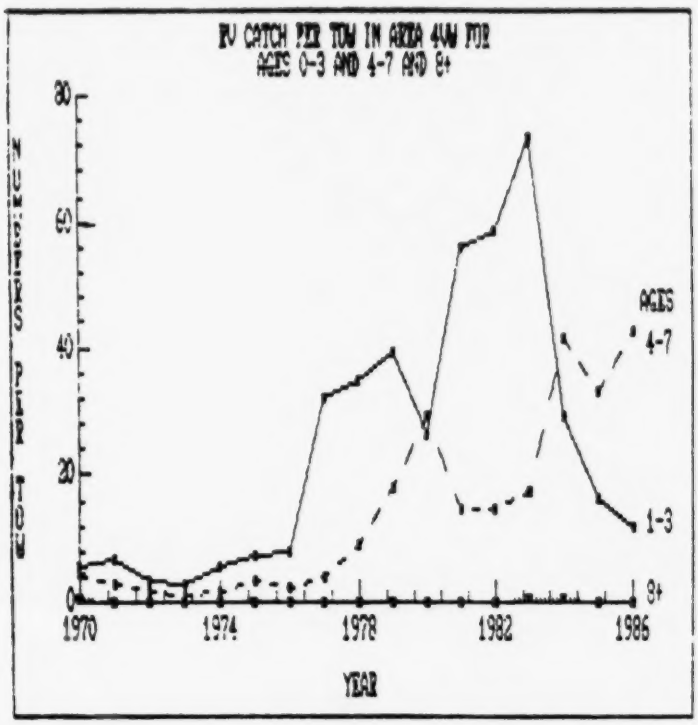


Figure 4. Mean catch per tow for haddock in 4VW during July groundfish surveys 1970-1986. Data are given for three age ranges (1-3, 4-7, 8+) separately.

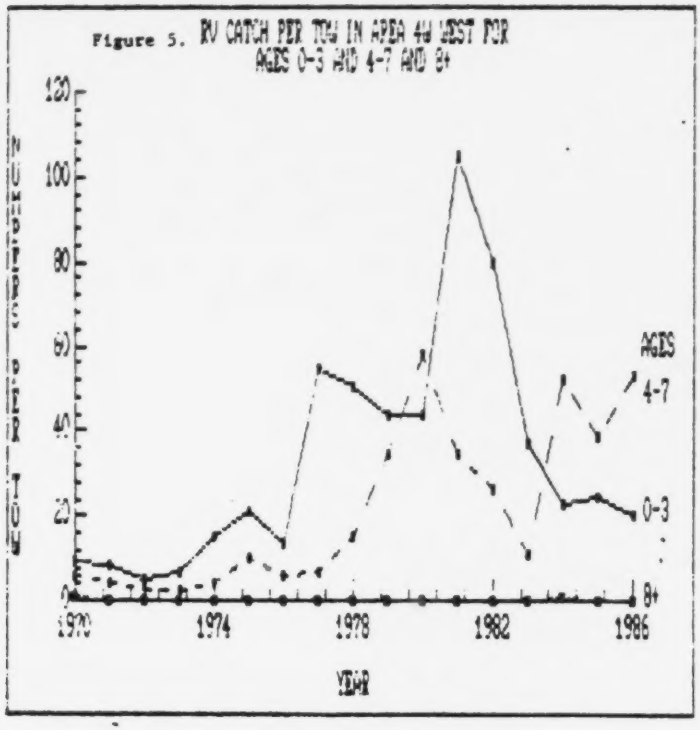


Figure 5. RV CATCH PER TOW IN AREA 4W WEST FOR AGES 0-3 AND 4-7 AND 8+
NUMBERS PER TOW
120
100
80
60
40
20
0
1970
1974
1978
1982
1986
YEAR
AGES
4-7
0-3
8+

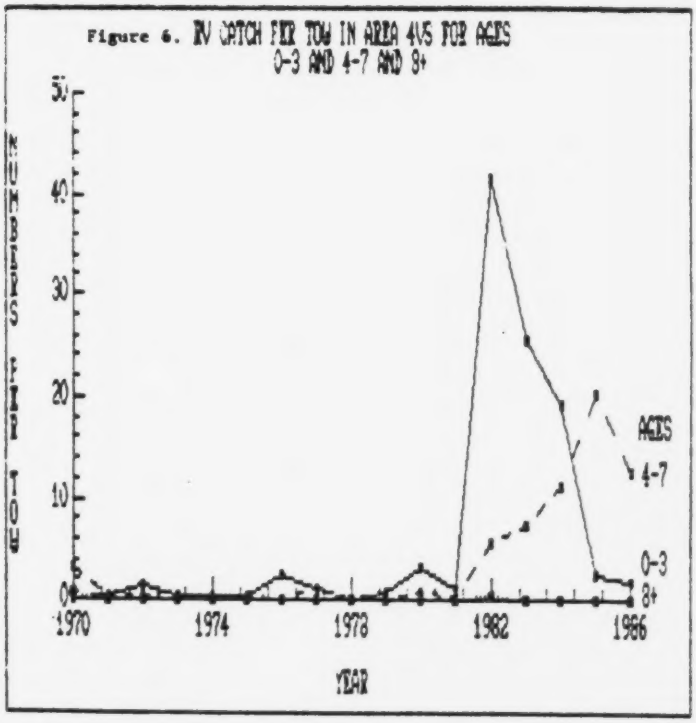


Figure 6. RV CATCH PER TOW IN AREA 4VS FOR AGES 0-3 AND 4-7 AND 8+
NUMBERS PER TOW
50
40
30
20
10
5
0
1970
1974
1978
1982
1986
YEAR
AGES
4-7
0-3
8+

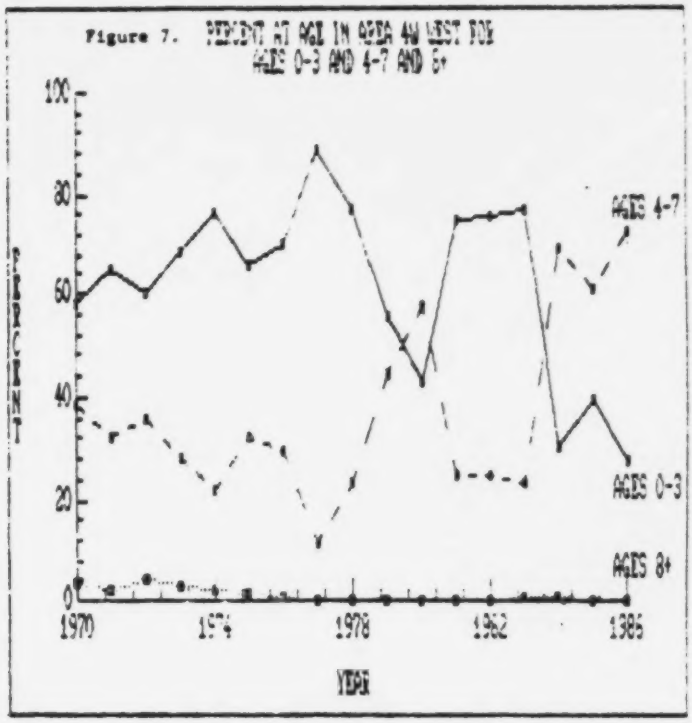


Figure 7. PERCENT AT AGE IN AREA 4W WEST FOR AGES 0-3 AND 4-7 AND 8+
100
80
60
40
20
0
PERCENT
AGES 4-7
AGES 0-3
AGES 8+
1970
1974
1978
1982
1986
YEAR

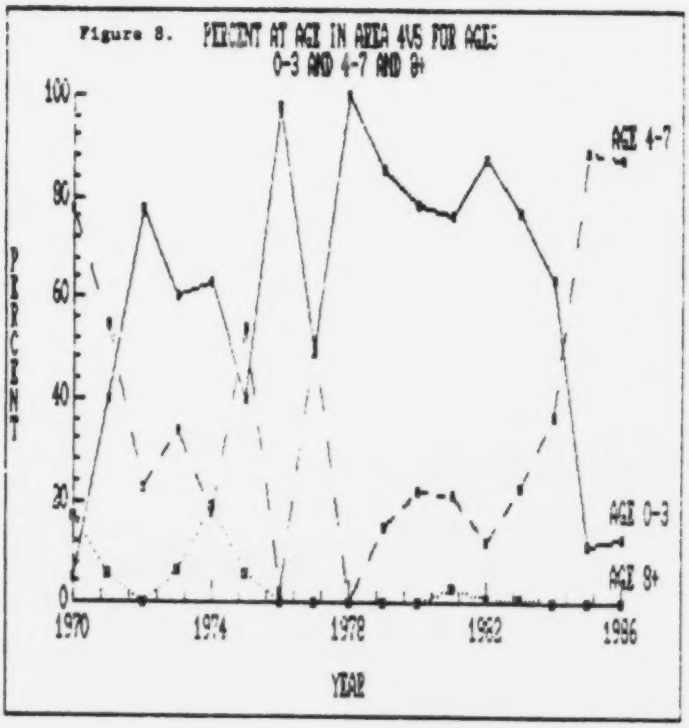


Figure 8. PERCENT AT AGE IN AREA 4VS FOR AGES 0-3 AND 4-7 AND 8+
100
80
60
40
20
0
PERCENT
AGE 4-7
AGE 0-3
AGE 8+
1970
1974
1978
1982
1986
YEAR

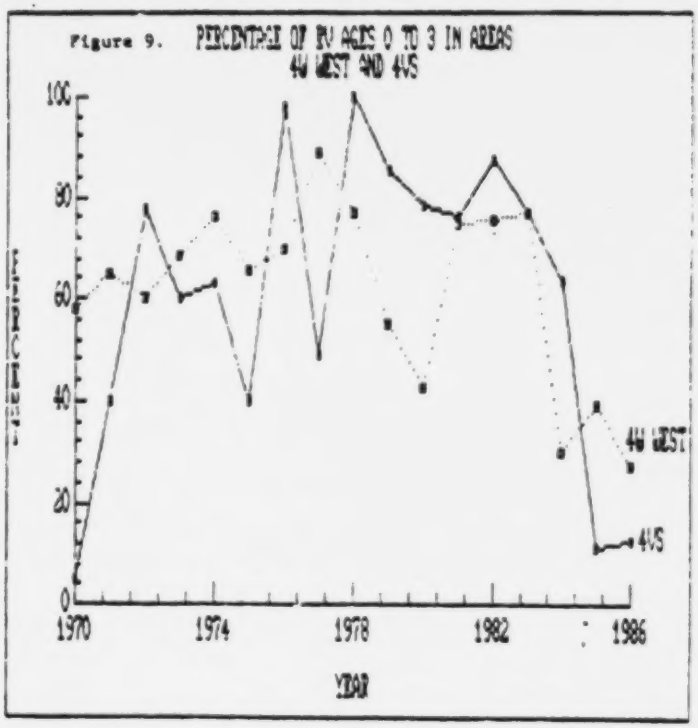


Figure 9.
4W WEST AND 4VS
100
80
60
40
20
0
1970
1974
1978
1982
1986
YEAR
4W WEST
4VS

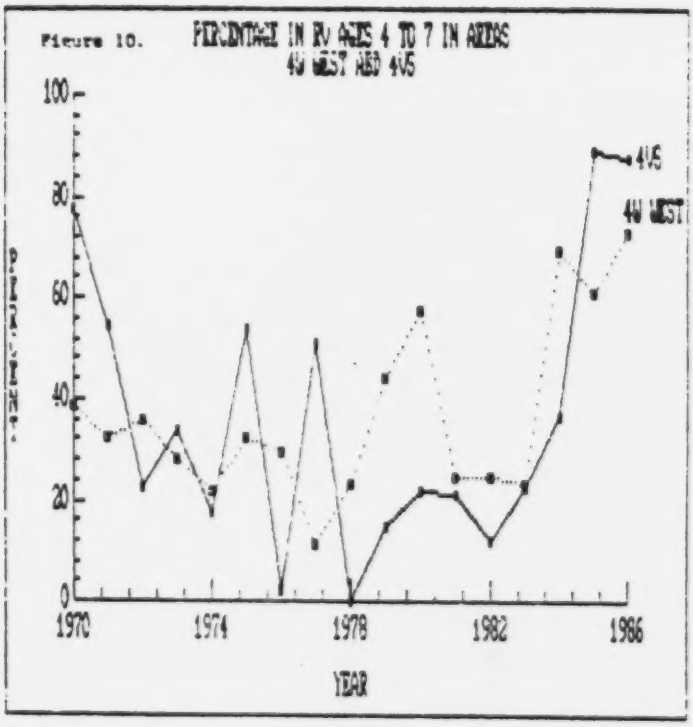


Figure 10.
4W WEST AND 4VS
100
80
60
40
20
0
1970
1974
1978
1982
1986
YEAR
4VS
4W WEST

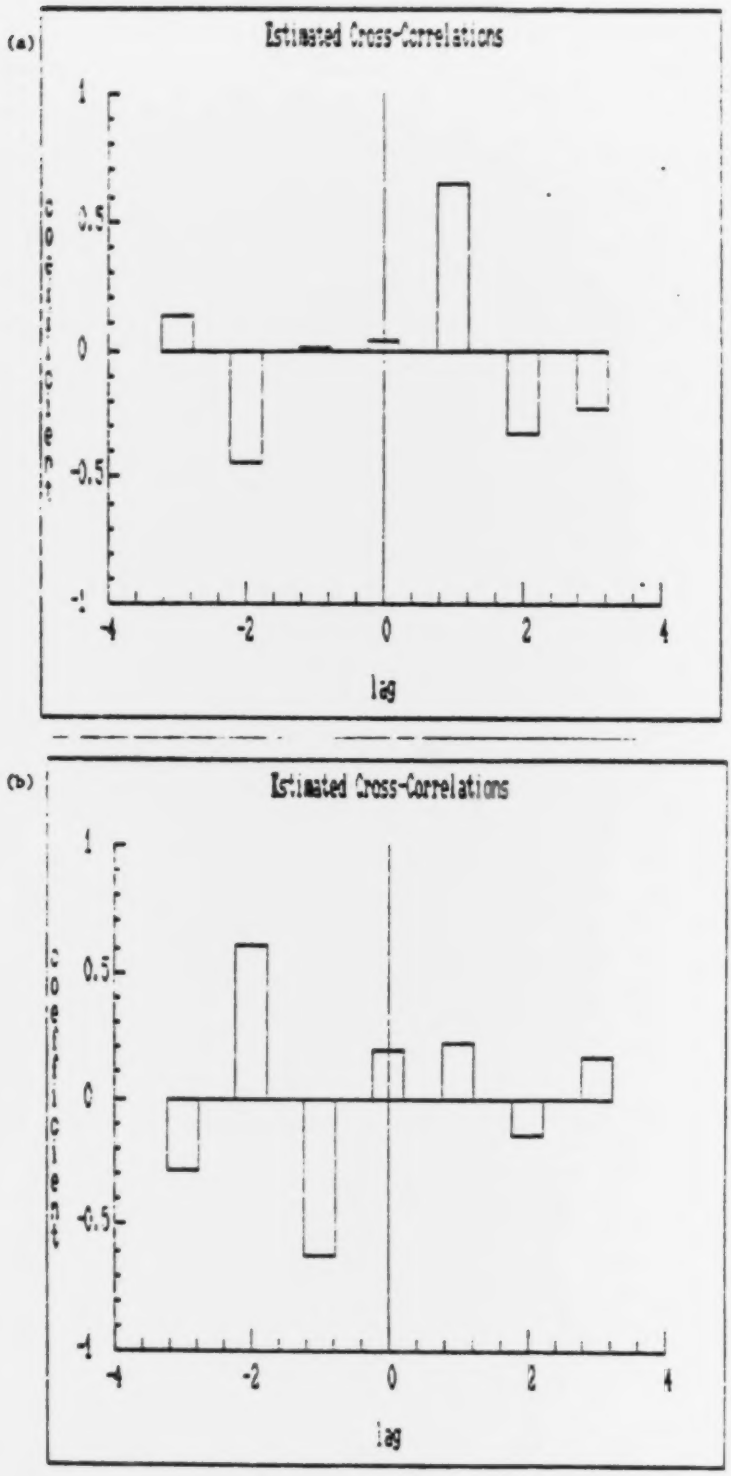


Figure 11. Cross correlations of 4W-West haddock with itself between ages 1 and 2 (a), 2 and 3 (b), and 3 and 4 (c).

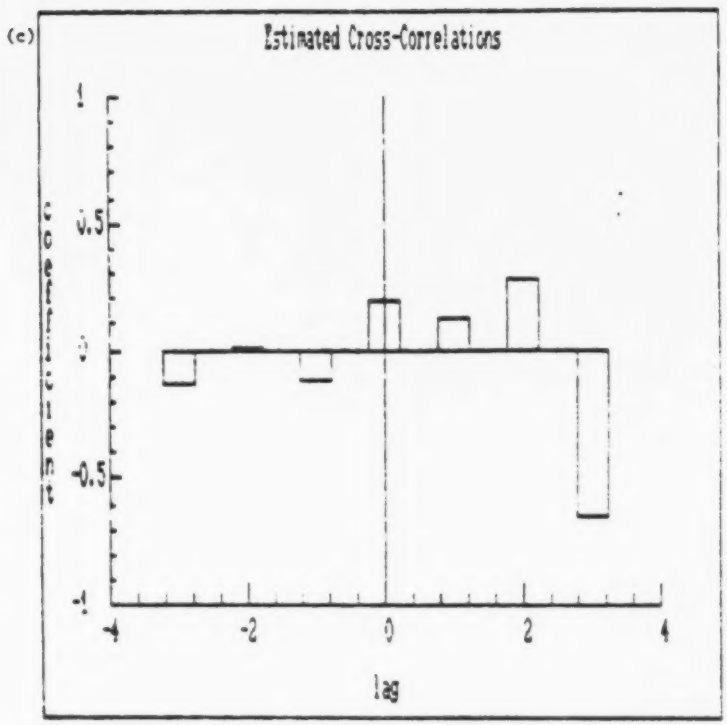


Figure 11. (Continued)

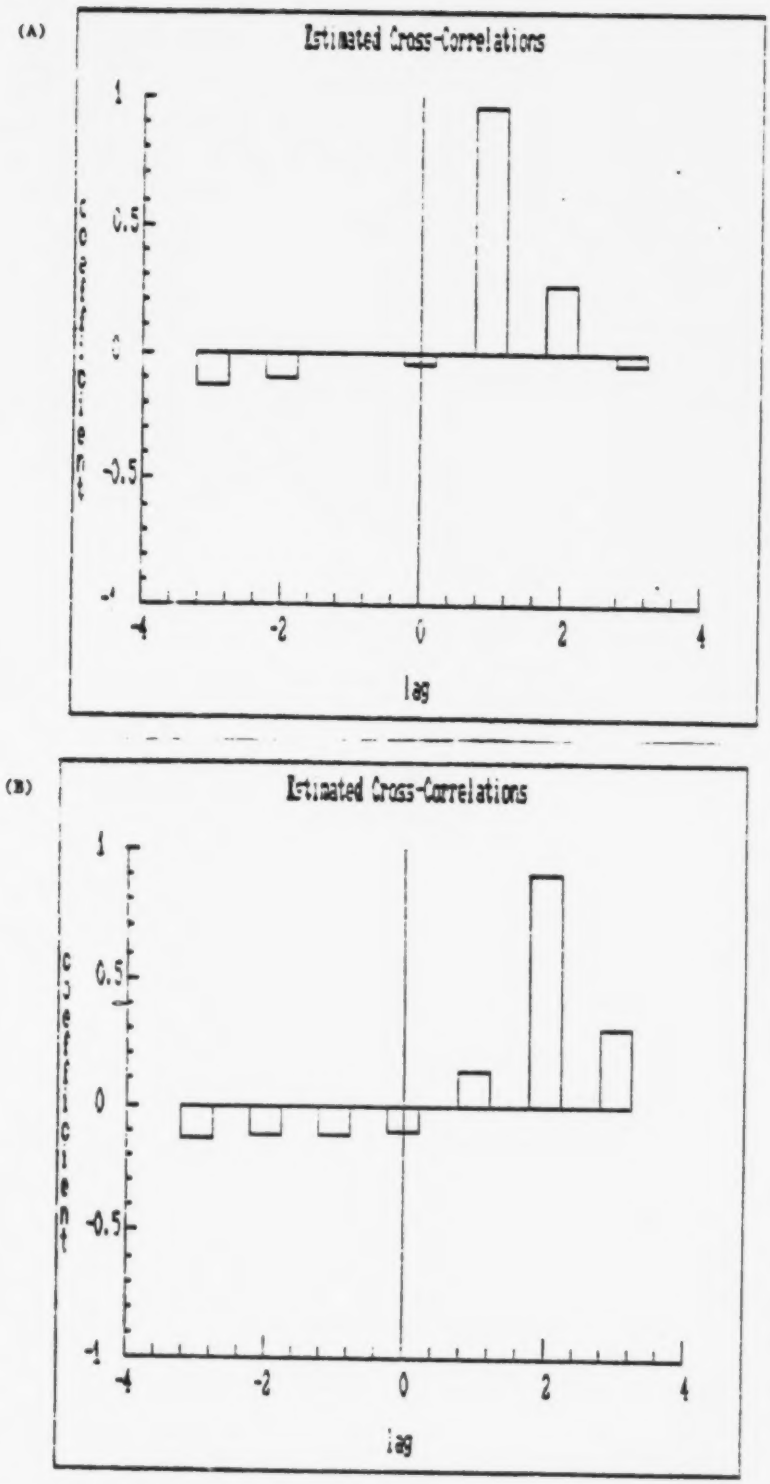


Figure 12. Cross correlations of 4W-West with 4Vs haddock between ages 0 and 1 (A) and 0 and 2 (B).

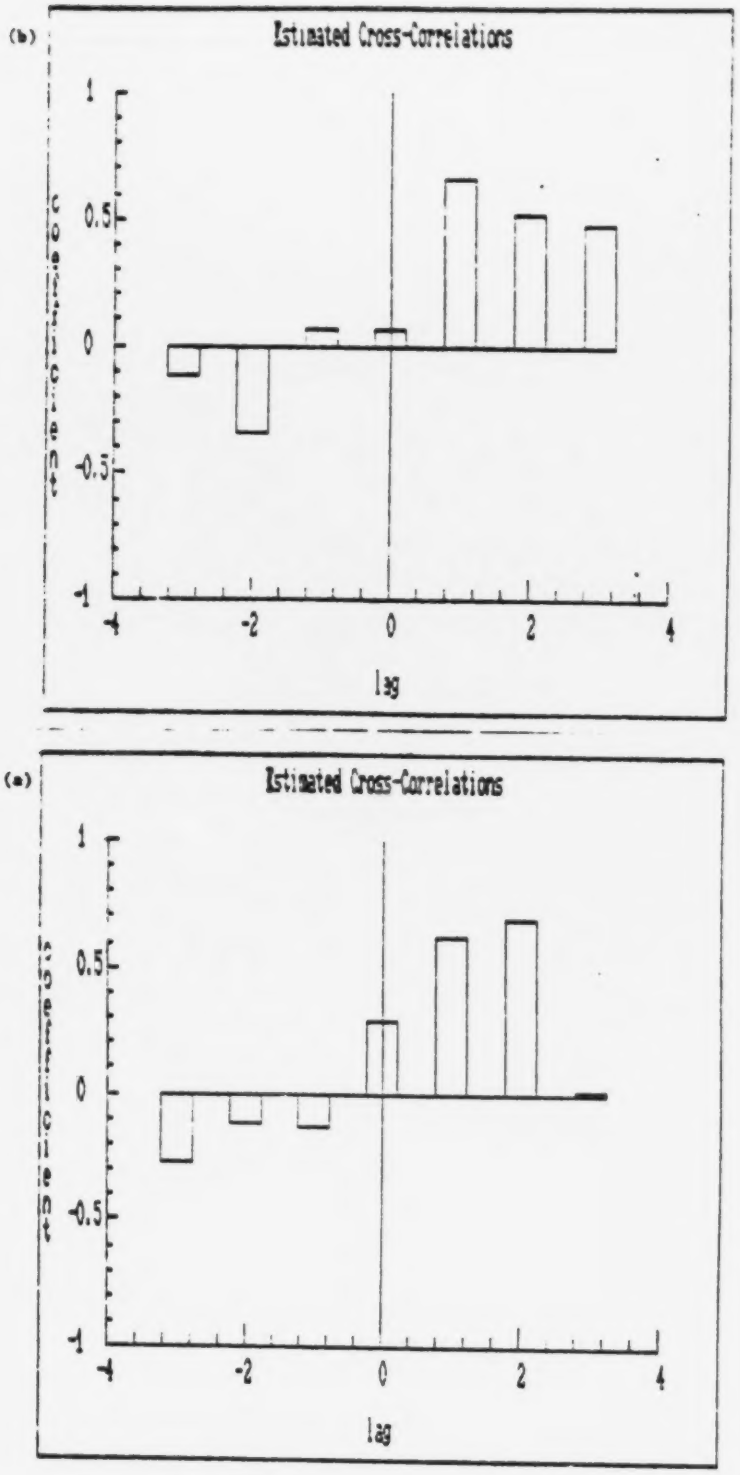


Figure 13. Cross correlations of 4W-West with 4Vs haddock at ages 1 and 2 (a) and 2 and 3 (b).

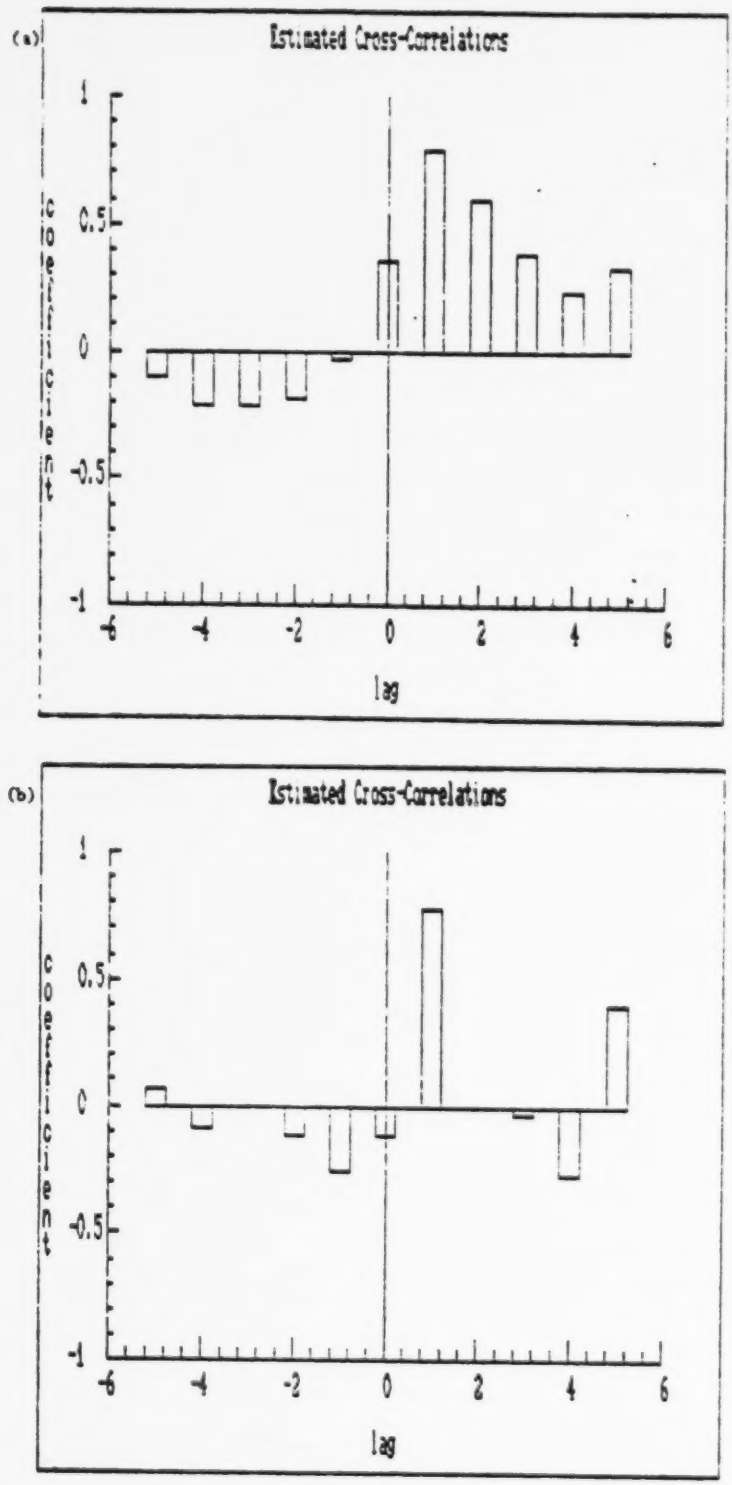
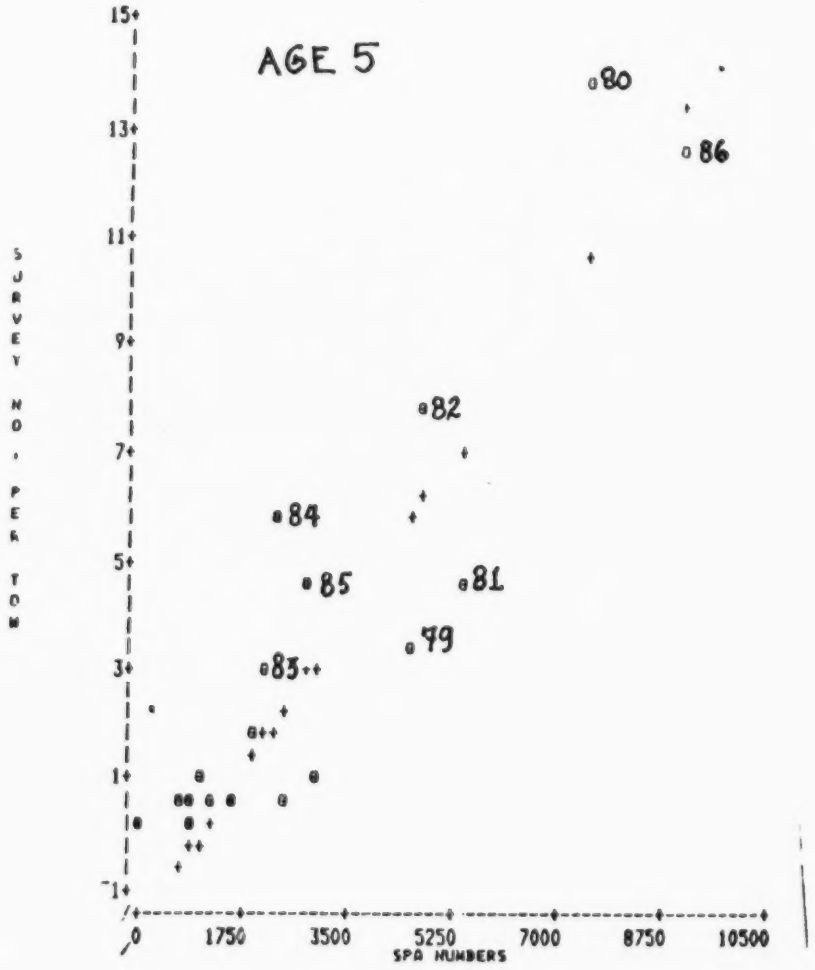


Figure 14. Cross correlations of 4W-West with 4Vs haddock between ages 0-3 for each area without differencing (a) and with differencing (b).



SUMMARY OF DATA FROM PLOT

CARRIER VARIABLE: POPULATION NOS

RESPONSE VARIABLE(S): SURVEY - o:OBSERVED, +:PREDICTED

INDEX	CARRIER	o	+	RANK
1970	2957.2	1.014	3.1034	1975
1971	2531.1	0.664	2.3908	1974
1972	1578.5	0.488	0.7978	1973
1973	940.5	0.154	-0.2693	1976
1974	891.5	0.566	-0.3512	1978
1975	727	0.448	-0.6263	1972
1976	1015.1	0.957	-0.1444	1977
1977	1963.7	1.979	1.4419	1983
1978	1183.2	0.5	0.1367	1984
1979	4634.2	3.309	5.9078	1971
1980	7448.2	13.944	10.6137	1985
1981	5358.6	4.583	7.1192	1970
1982	4800.5	7.7	6.1859	1979
1983	2171.8	2.835	1.79	1982
1984	2223.7	5.786	1.8767	1981
1985	2804.1	4.741	2.8472	1980
1986	9116.5	12.632	13.4037	1986

Figure 15a. Relationship between SPA numbers at age 5 and observed numbers from surveys at age 5 resulting from a terminal F at age 6+ of 1.00 and the PR vector given in the text.

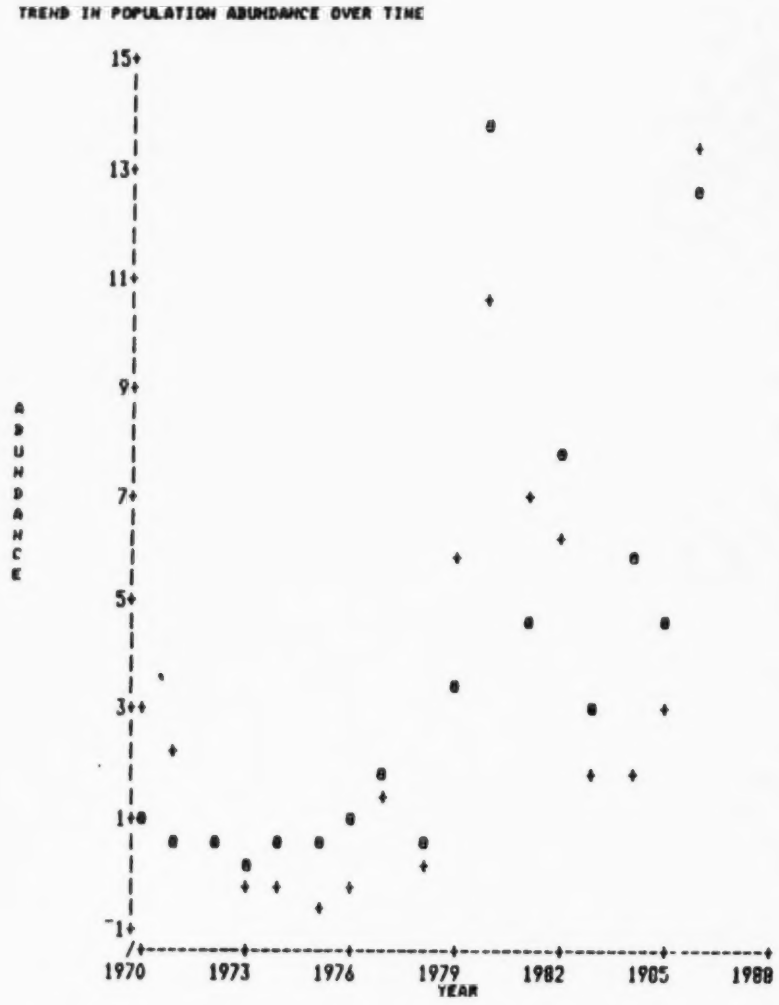


Figure 15b. Trends in population abundance at age 5 over time as predicted from the relationship given in a. (+) and observed from surveys (0)

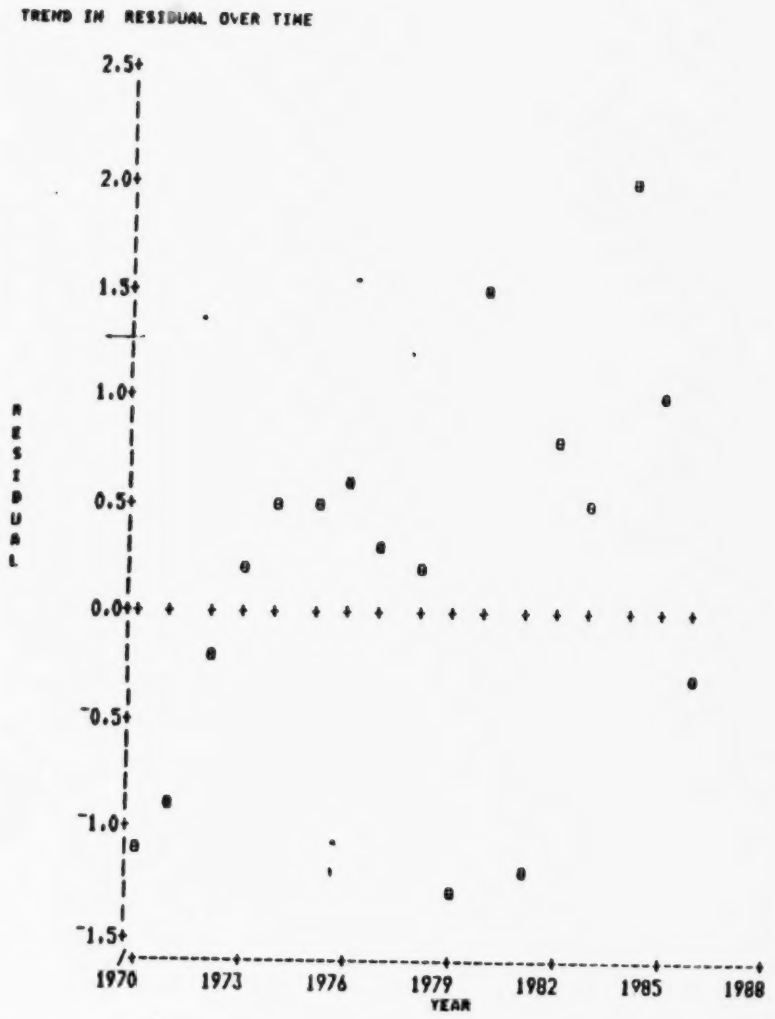


Figure 15c. Residuals of observed and predicted values of population trends given in b.

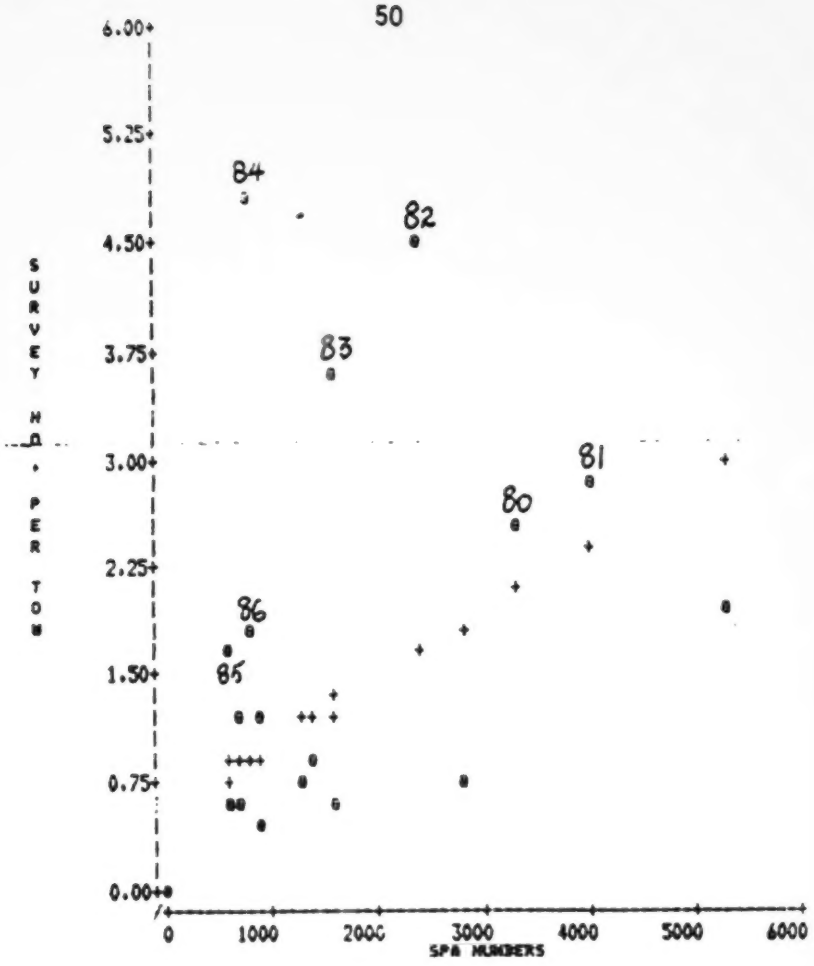


Figure 16a. Relationship between SPA numbers at age 6 and observed numbers from surveys at age 6 resulting from a terminal F at age 6+ of 1.00 and the PR vector given in the text.

SUMMARY OF DATA FROM PLOT

CARRIER VARIABLE; POPULATION NOS
RESPONSE VARIABLE(S); SURVEY - 0;OBSERVED, +;PREDICTED

INDEX	CARRIER	0	+	RANK
1970	5340.7	2.015	2.9497	1974
1971	2775.9	0.785	1.8032	1985
1972	1639	0.652	1.295	1975
1973	921.2	0.433	0.9742	1976
1974	579.7	0.665	0.6215	1984
1975	706	1.229	0.878	1986
1976	747.4	0.621	0.8965	1977
1977	882.1	1.219	0.9567	1973
1978	1345	0.711	1.1636	1978
1979	1388.8	0.846	1.1832	1979
1980	3291.2	2.552	2.0335	1983
1981	4029.1	2.808	2.3634	1972
1982	2432.2	4.432	1.c496	1982
1983	1591.7	3.571	1.2739	1971
1984	831.4	4.861	0.934	1980
1985	623.2	1.614	0.841	1981
1986	837.8	1.748	0.9369	1970

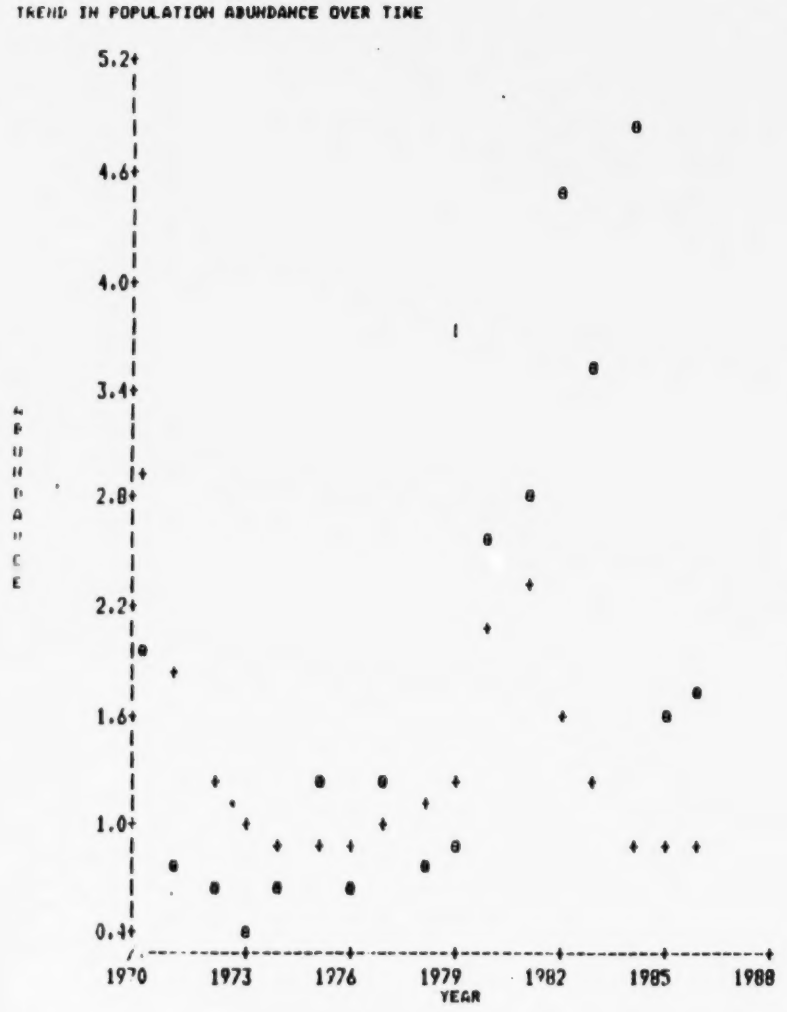


Figure 16b. Trends in population abundance at age 6 over time as predicted from the relationship given in a.(+) and observed from surveys (θ).

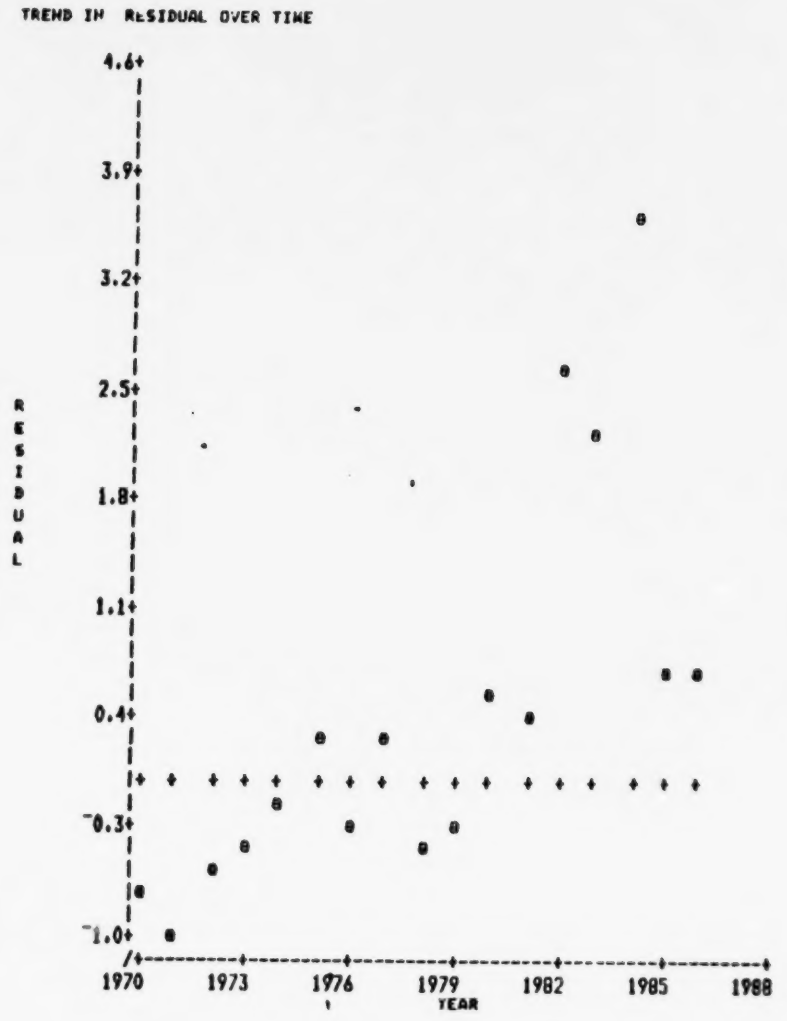


Figure 16c. Residuals of observed and predicted values of population trends given in b.